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The Bryant Street Power House.

The Journal of Electricity

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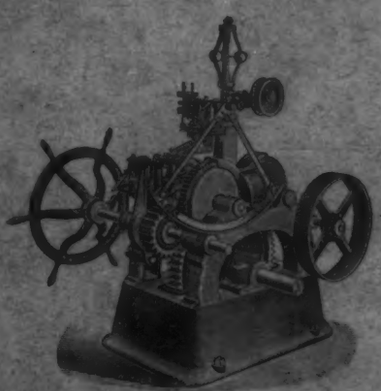

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The Journal of Electricity

VOL. IV. JULY, 1897 No. 4

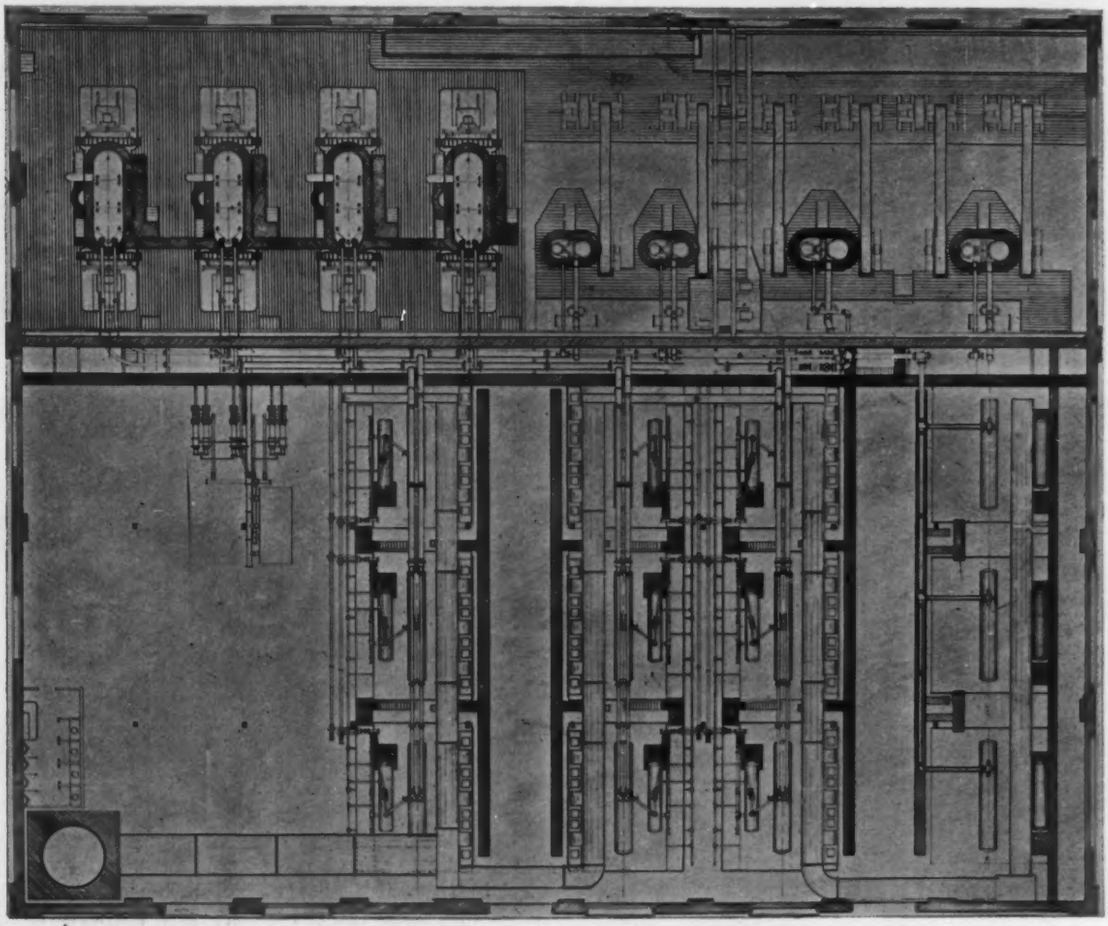
The Bryant Street Power House.

By W. W. HANSCOM, M. E., E.

The General Power House of the Market Street Raiway Company is located on the block bounded by Bryant, Alameda, York and Channel Streets, San Francisco.

During the year 1893 grading was commenced on the present site and the following year saw a brick building with a frontage of 165 feet on Bryant street, extending half-way back to York street and ending in a wooden partition which was to be removed when demands required an additional power house space. The fire room fronts on Channel street, alongside the steam railroad track, and convenient for coal supply, while the engine room, separated from it by a 24-inch brick wall, fronts on Alameda street. This location is in about the center of the car district and is well situated for supplying the new districts now being built up.

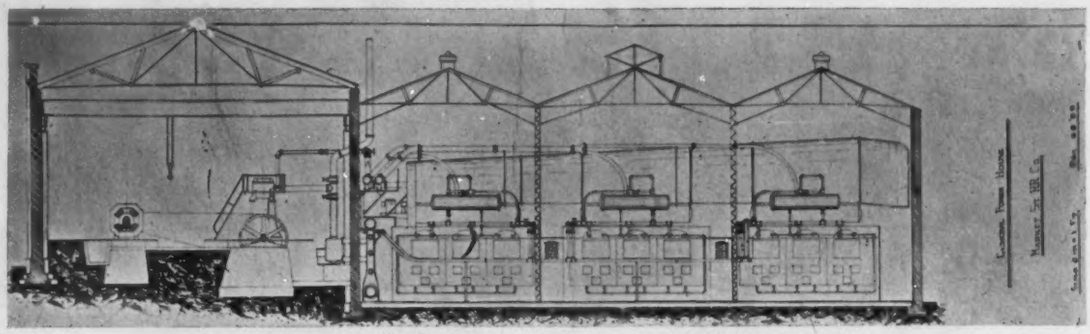
The plant as originally laid out consisted of four Union Iron Works compound engines, two being of 300 horse-power and two of 600 horse-power, belted to six General Electric 200 kilowatt multipolar compound wound generators and nine "Elephant" horizontal return tubular boilers designed for 130 lbs. working pressure and set in batteries of three, arranged for hand firing with natural draft. Early in September of '94 the plant was started, but owing to the non-



GROUND PLAN OF THE BRYANT STREET POWER HOUSE.

completion of the pumping station, which was to supply condensing water, the engines were run non-condensing until the following April, 1895.

In the meantime during the construction of the power plant, the old horse car line on Miss'on street had been reconstructed into a modern overhead trolley electric system and power was first supplied to operate the cars on this road. Third, Kentucky, Fillmore, Bryant and Solano streets soon followed, and later on, Kearney, Broadway, and Fourth streets and tributaries. The Metropolitan Electric System was operated from a separate power house on Carl street, but



ELEVATION OF BRYANT STREET POWER HOUSE.—BOILER ROOM SIDE.

was later supplied from the Bryant street power house and the Carl street station was then shut down. The increased demand for power soon necessitated an increase in the supply and orders were placed with the Union Iron Works for a 1300 horse-power direct-connected, triple expansion unit with the necessary boilers, etc., together with a switch board of sufficient capacity for contemplated and future developments. The boilers were three in number, of the same type as the first, but differently fitted, and the board was commenced at both ends and gradualy filled in toward the center, the circuits being changed from the old one as fast as the new one was installed. The new unit was not connected in common with the old belted ones immediately, but was run on separate circuits during the heavy load period and shut down at night when the load was light enough to be carried by the smaller engines. The new unit operated with steam at 160 lbs. working pressure. An overhead electric traveling crane was also installed and later, three more similar units were ordered and installed, and a tool room and workshop were fitted up in a corner of the fire room handy to and opening into the engine room.

The present plant consists of nine boilers in batteries of three, each being 64 inches diameter by 16 feet long, designed for 130 lbs. working pressure and fitted with the United States rocking grate bar, and operated under natural draft with hand stoking; also,

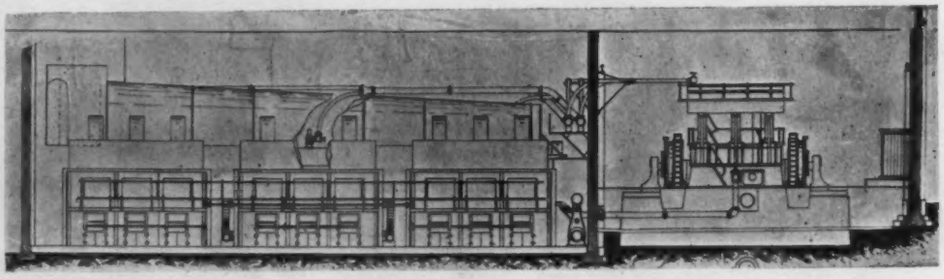
27 boilers, each being 64 inches diameter by 16 feet long, arranged as the above, in a row of three batteries of three boilers, and being designed for 160 lbs. working pressure and equipped with Roney mechanical stokers and Howden forced draft system.

Two 300 horse-power compound condensing engines, cylinders 16-28 inches by 24 inches stroke, 160 revolutions per minute, with cranks 180 degrees apart, and

Two 600 horse-power compound condensing engines, cylinders 22½x39x24 inches stroke, 160 revolutions per minute, with cranks 180 degrees apart.

The smaller engines have one and the larger engines have two fly wheels, each 9 feet in diameter, with 25 inch face and weighing 12,000 lbs. each. Each fly wheel is belted to the pulley of its generator by a 24 inch double leather endless belt. One of these engines (600 horse-power) is shown in accompanying illustration. Each engine is equipped with an independent condenser and air pumps, the circulating water being supplied under a sufficient head for circulating purposes. Steam is furnished each engine from a large receiver and its admission into the high pressure cylinder is governed by a shaft governor of the Ide type, the cut off on the low pressure cylinder being fixed. Both cylinders are steam jacketed.

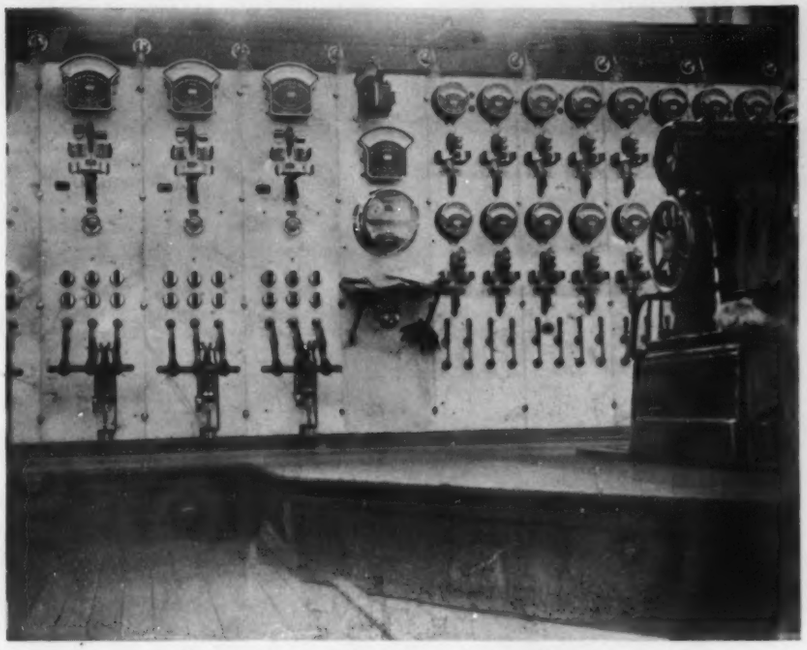
Four 1300 horse-power triple expansion engines, with cylinders 20-30-44 by 30 inch stroke, running at 150 revolutions per minute. As in the compound engines, the steam entering the high pressure cylinder is regulated by a shaft governor, the cut off in the intermediate and low pressure cylinders being fixed. The outside steam receiver is replaced by one embodied in the high pressure cylinder casting and acting as a jacket to the cylinder. The throttle valve is connected to both mains through stops alongside on top of high pressure cylinder. All cylinders and covers are steam jacketed and the valves are fitted with balance pistons on continuations of the valve stems.



ELEVATION OF BRYANT STREET POWER HOUSE—SIEMENS-HALSKE END.

The air pumps on these engines are driven from the intermediate cross heads by rocker arms and the condensers are a part of the bed plates and have the circulating water outside the tubes in contact with the bed plate, insuring a minimum amount of heating in the journals. All bearings and slides are arranged for water circulation, the supply being taken from the

injector by a donkey pump, and the discharge from each bearing, etc., is in plain view from the back of the engine. The top platforms are connected by flying bridges with each other, making a continuous path for the oiler from one engine to the other. The cranks are at 120 degrees and the large diameter of the Siemens & Halske armatures renders the use of fly wheels unnecessary.



CENTER PANELS OF THE SWITCHBOARD.

The bearings throughout are fitted with wick oil feeds, as in marine work, the reservoirs supplying a number of bearings depending on their location. Each reservoir receives oil from a common supply pipe leading from the main supply tank under the engine room floor. The drips are caught in pits and led to the filter system alongside the supply tank, and when purified are pumped into it under an air pressure of from 15 to 20 pounds. The entire arrangement is very economical, but 50 gallons of oil being used per month in the eight engines.

Circulating water is supplied by a pumping station situated alongside the bay on Kentucky street and connected to power house by 6000 feet of 36 inch cast iron pipe. In the station are two centrifugal pumps, each belted to a 150 horse-power General Electric motor, 500 volts, receiving current from the power house and controlled by rheostats in the field and armature circuits. But one of these is required at a time. A stand pipe in the pump house regulates the supply pressure and takes care of the surge in the pipe. The water is supplied under a pressure of about 15 lbs.

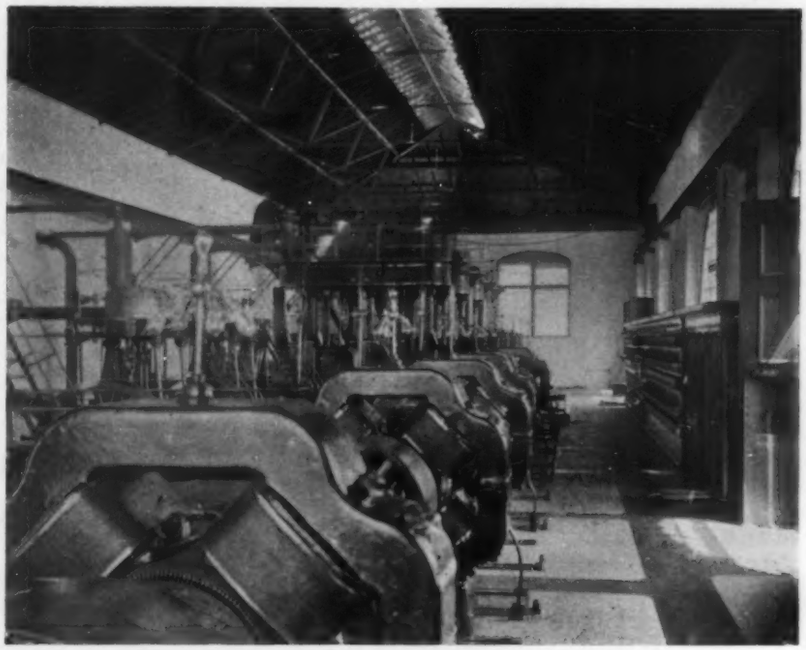
At the power house the discharge is carried into the street sewer by a system of pipes and valves acting as a siphon and relieving the pumps of some of their duty. One of the small engines at the power house is started on the atmosphere in the morning to start the pump motor. The salt water is also used by the water cars for sprinkling the road beds, and a connection with switch valves permits of the fire pump drawing salt water from either the supply or discharge at the power house.

The pumping station is operated on a ground return with an auxiliary wire so connected at the power house as to be inside the circuit breakers and fused at the pump station as to be disconnected from the ground and used as a return in case of the main breakers going out.

The generating equipment consists of:

Six 200 kilowatt General Electric multipolar compound wound railway generators, 500-590 volts, running at 480 revolutions per minute. These are belted to the compound engines, one to each 300 horse-power and two to each 600 horse-power.

Eight 400 kilowatt Siemens & Halske 6 pole, external armature generators (500 to 590 volts, at 150 revolutions), are directly connected to crank shafts of the 1300 horse-power engines, one on each end. They are connected to the same bars and in multiple with the General Electric generators, the necessary adjustments on all machines being made by shunts across the positive and equalizer wires at back of switchboard, so that the load is evenly divided amongst the machines in proportion to their capacities.

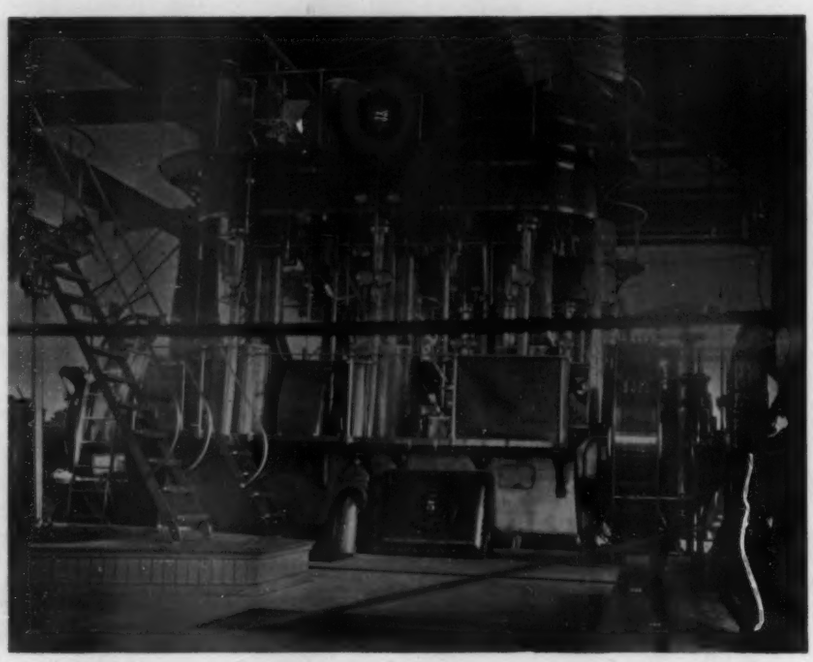


A GENERAL VIEW OF THE GENERATING ROOM.

The leads from dynamos to the switchboard are taken down through the engine room floor, into large conduits, thence along and up the back of the board to the terminals.

The switchboard, which is designed for a maximum output of 10,000 amperes, is of white California marble, 2 inches thick, and mined from the quarries of the Inyo Marble Company. It is 59 feet long by 8 feet high and is set 5 feet away from the wall and in the center of the length of the station. There are 29 panels, each being two feet wide, the fourteen to the left of the center being connected to the generators, and the fourteen to the right, to the feeder circuits. The center panel is fitted with Weston illuminated dial ammeters and voltmeters, the latter on a swinging bracket, the former being connected in the bus bar between generators and feeders. A Thomson recording wattmeter and log desk complete this panel. Each generator panel has mounted upon its face an illuminated dial Weston ammeter, a Westinghouse circuit breaker, a shunt field rheostat, a cut-in voltmeter plug, a triple-pole main switch, and a Siemens & Halske carbon shunt field switch, which opens the shunt circuit gradually through a pair of carbon points, slowly separated by means of a worm wheel and crank. The generators being of different sizes, the scales on the ammeters are so graduated as to indicate a correct distributon of load when the needles occupy the same angular position.

Each of the feeder panels is arranged to supply four circuits, each of 400 amperes, having a round dial Weston ammeter, Westinghouse circuit breaker and single-pole switch for each circuit. The top and ends of the board are finished off with polished teak molding, the lamps for illuminating the board being fastened to the top molding. The feeder wires lead from the bottom terminals of the switches through the floor and along the conduit underneath to the end of building, thence up and out. A test of the regulation of the four compound engines made on August 30, 1895, for ten minutes, with four counters, one on each engine, all being started and stopped simultaneously by an electrical attachment, showed as follows:



A 1300 H. P. UNION IRON WORKS AND SIEMENS-HALSKE SET.

Engine No. 1—600- horse-power, load varying from 300 to 690 amperes, 1589 revolutions.

Engine No. 2—600 horse-power, load varying from 300 to 690 amperes, 1589 revolutions.

Engine No. 3—300 horse-power, load varying from 150 to 345 amperes, 1592 revolutions..

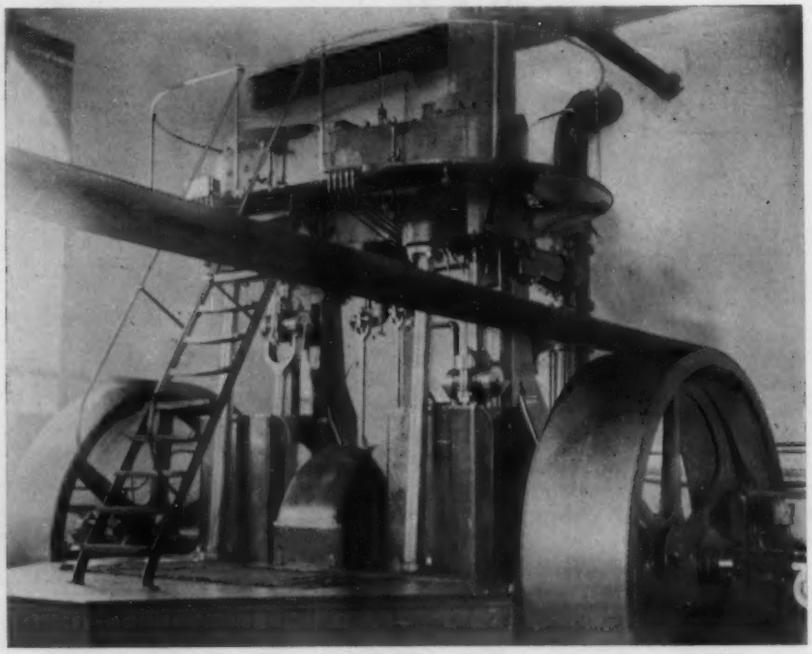
Engine No. 4—300 horse-power, with generator excited only, throttle wide open, 1594 revolutions.

The steam pressure during this test was 30 lbs., the vacuum being 126 inches.

The maximum current of the station at present reaches 6000 amperes and the average for 21 hours is 2200 amperes.

BICYCLISTS, BEWARE!

The State Supreme Court has held, in the case of Everett vs. the Los Angeles Consolidated Electric Railway Co. (34 Lawyers' Reports, Annotated 350, that a person riding between the rails of an electric railway upon a bicycle is chargeable with the duty of looking out for and endeavoring to avoid danger from the electric cars; and the motorman seeing him is entitled to assume up to the last moment that the rider will turn out of the way by increasing his speed or turning aside to avoid the danger.



A 600 H. P. UNION IRON WORKS ENGINE DRIVING TWO GENERAL ELECTRIC GENERATORS.

Pneumatics

COMPRESSED AIR FOR MINING PURPOSES.*

By Edward A. Rix.

(Continued from Page 54.)

The requirements of the ordinary mine in this State, as far as power is concerned, may be enumerated as follows: Power for hoisting, for both surface and underground pumps, for rock drills, for milling and for lighting, for forge blasts and the mine whistle, which must be provided for some way, as it serves to mark the shift changes and give the fire or accident alarm.

I will take up each of these heads, briefly; speak of the prevailing practice here, and how it can be improved; and in any comparisons I may make between the efficiency of compressed air and any other power, I shall assume that the horse-power in each kind of power costs the same, ready to deliver to the various motors.

Before speaking of the various motors to develop the required power, we shall assume that our mine is properly equipped with conduits and reheating apparatus. Too much stress cannot be laid upon the fact that generous air conduits on the surface and underground, properly provided with bends or elbows of large radius and properly insulated where they convey hot air, contribute greatly to the economical operation of an air plant.

While the actual loss to the compressed air in its potential, by the drop in pressure, caused by friction in small pipes, is not more than one-third of what the public believes it to be, still the annoyance in not getting initial pressure where small working cylinders are used, is great and again, the increased velocity in small pipes down a shaft deprives the compressed air of a gain instead of a loss of power as it goes downward, which it would have in proper sized conduits.

Illustrating the first point, it is generally assumed, for instance, if a compressed air pipe receives air at 100 pounds and delivers it at 80 pounds, that the loss is twenty per cent. So it is, in pressure; but relative pressures do not measure such a loss, for while the pressure has decreased, the volume has correspondingly increased, and the real loss is merely a fric-

The Bryant Street Power House.

General View of Switchboard.

tional one of 8.4 per cent instead of twenty.

Illustrating the second point, there is a very material gain to be had from the weight of air in average shafts, provided the pipes are of proper size. Air at 90 pounds gauge on the surface would be 92 pounds at 500 feet, 94 pounds at 1,000, 96 at 1,500, and 98 at 2,000 feet—a gain sufficient to offset all frictions and ordinary leakage, a proportion which cannot be matched in electrical transmission down a shaft.

Most of the air plants in our mines are inefficiently piped, and no attention whatever is paid to long bends, and the pipes in general appear to be specially installed to exhibit every class and variety of pipe fitting the market affords, and with many duplicates. I have counted five 1-inch elbows in the space of three feet to connect up a pump to the main air pipe, when the price of 1-inch hose and couplings would have been less and the hose would have delivered to the pump nearly the line pressure. The pressure loss in each of the 1-inch elbows would be (.005V2-3) five-thousandths of the square of the velocity of the air through

* Lecture delivered to the engineering students of the Leland Stanford Junior University, May 3, 1897.

the pipe. The pump had a six-inch cylinder and the piston moved fifty feet per minute. The ratio of the cylinder area to the pipe being 1 to 36, the air in the pipe must move 1,800 feet per minute, or 30 feet per second. This squared and multiplied by five one-thousandths makes a loss of 4½ pounds for each elbow, or 22 pounds for the five, certainly not a sensible or desirable result, yet one sees it everywhere in the mines. The passion miners have for 1-inch pipe is marvelous. One may frequently see strings of it five hundred feet long, conveying air. It has cheapness and ease of installment to recommend it, but the wood pile and the owner suffer. A proper plant should have no 1-inch air pipe underground over ten feet long, and no short elbows.

At some convenient place, where the total length of air conduits from the surface motors shall be a minimum, a good reheater should be established and connected to all these motors. There is ample scope to improve upon the reheaters now upon the market. They may be classed as coil, tube and shell reheaters. The former a simple or nest of coils within a furnace; the tube reheater consisting of a nest of pipes screwed into a cast-iron head, and all surrounded by a furnace; the shell reheater made much like an ordinary domestic sheet-iron heater, except that it will sustain pressure, the fire being within it.

Any of these will do fairly well, especially if well insulated on the outside to prevent surface radiation. They should be provided, in large plants, with pyrometer and proper dampers, to prevent overheating. We build also a compound reheater, which contains two independent heating compartments for different pressures, the utility of which will be seen later on.

A very small amount of fuel will be used in one of these reheaters—just about half a cord of pine wood a day, to reheat 100 horse-power of cold air so that it will yield 140 horse-power. When it is remembered that one-half a cord of pine wood will yield at the maximum 8 horse-power for twenty-four hours, when burned under a steam boiler, its capacity to produce 40 horse-power is a little short of incredible. Besides doing this, it renders still further service by permitting us to use the compressed air in an expansion engine.

Some engineers use a steam boiler for a reheater, especially if it is already installed at the mine. A slow fire is maintaned on the grates, and about eighty to ninety pounds steam pressure maintained; the compressed air bubbles up through the hot water and mingles with the steam. Fully ninety per cent of the mixture is air. This system has earnest advocates who claim that the latent heat of the condensing steam being released in the motor cylinder just where it is then ended, and the condensed water acting as a lubricant, makes this system preferable. It is certain that the heat can be carried farther this way, but we lean to the classes of dry reheaters mentioned first because they are simpler, will give higher temperatures, and require less fuel.

A temperature of 450 deg. Fahr. can easily be maintained in the dry reheater, and with well insulated pipes this will insure 400 deg. Fahr. to all motors contained within the ordinary hoisting works with mill adjoining.

There should be installed, at the end of the compressed air transmission pipe, ample reservoir capacity. This is, next to reheating, the most important feature in a compressed air plant for mining work, and it is in the proper arrangement of this particular feature that we make a great gain in economy over electrical power for intermittent work.

The two sets of machines which take the most power around a mine are the rock drills and the hoists. These use large powers for short periods, and frequently the average power covering twenty-four hours is, in the case of the hoist, from one-third to one-fourth the maximum, and with rick drills about one-half, where more than three machines are in use. It is evident, therefore, that if sufficient storage capacity be provided, the average power will only be demanded from the transmission main, while in an electrical plant the maximum power must be continually delivered by the transmission, for it may be required at any moment. This makes it an expensive proposition to use electricity for intermittent work.

True, storage batteries would accomplish the desired end, but who dares face their first cost and cost of maintenance.

As an instance of the relation of storage to intermittent work I will cite the case of the Banner Mine, at Oroville, California, that has a compressor having a single double-acting 10½ by 12 inch air cylinder; the piston makes 300 feet per minute, and the machine is probably delivering 150 cubic feet of free air per minute. This size of machine is rated by builders as a two-drill compressor, yet it is driving two 3⅛-inch machines, one 3½-inch, one 2¾-inch, and, on occasion, a 2-inch also. The united requirements of these machines, should they be running at the same time, would be 285 cubic feet per minute—almost double the output of the compressor. The explanation lies in a very large and unnusual reservoir capacity—in fact, ten times larger than ordinarily employed with a compressor of that size. The wisdom and economy, however, of such large receiver capacity is apparent, and this example should be followed, especially as receivers are very expensive.

As an example of the advantage of reservoir capacity with a hoist, I call attention to the hoist at the North Star Mine, Grass Valley, which develops 80 to 90 horse-power when running, but calls on the compressors to exert but from 25 to 30 horse-power to maintain it. There are probably not five mines in the State with proper air reservoir capacity, and if it were possible to arrange contracts with the mine owners to yield up fifty per cent of the saving effected by putting in proper pipes and receivers, more than one person could earn a comfortable income by making such changes in this State alone.

Receivers should be placed at any general distributing point in the mine, as well as upon the surface. Anyone managing a mine, by keeping a record of two days only, of the length of time his intermittent machines are running during the day, can readily calculate the proper receiver capacity required.

Coming now to the machinery proper for the mine, first in order of installation is the hoisting works, which we will consider only from the standpoint of economy and utility. It is supposed, of course, that the elements of strength, safety, capacity and everything, have all been properly considered by whoever was the designing engineer. It is almost a rule that a mine that can afford to have an economical transmission plant has use for a hoist of sufficient capacity to enable it to be one of the highest motor type, and for this purpose I should install a compound hoist, direct-connected—that is to say, there will be no gear-

ing whatever on the hoist, the shaft carrying the drums being at the same time the engine shaft. The cylinders proportioned with reference to the initial and final pressures desired, and also with respect to the amount of expansion done by reheating. To get the largest amount of work from a hoist of this character the air should be reheated to about 400 degress before passing into the initial cylindtr. It will be exhausted from there back into the second compartment of the compound reheater, and heated again to 400 degrees; from there it will pass to the low pressure cylinder, perform its work and be exhausted to the atmospheric pressure.

It does not require any particular amount of calculation to show that with this double reheating the volume of the air may be practically increased from sixty to eighty per cent, with a corresponding degree of economy.

For the second reheating there is practically no extra fuel required, the second reheater being placed above the first one and absorbing the heat after it has passed through the first series of tubes. The piping on a plant of this kind should be so arranged that either cylinder can take the high pressure air, for either cylinder exhausts it directly into the atmosphere, as well as the piping for the operation of compounding.

A hoist of this character will be found much easier to care for than one operated by steam, for there will be no condensed water to be carried off, and the machine is ready to start in operation at a second's notice. There is no other manipulation, as far as the motive power is concerned, except the opening of the throttle valve.

In the operation of a hoist of this character the service of storage reservoirs in conjunction with compressed air service becomes very apparent, and, as stated before, a hoist which requires from 80 to 100 horse-power to operate while it is in service would in the average mine require but 25 to 30 horse-power at constant work delivered by the compressor. The advantage of this is apparent, and while it is approached by steam power, cannot be matched by any other service excepting by a water wheel plant having large reservoir capacity.

And for the reason which I have heretofore stated, it is evidently the very worst proposition for the economical use of electricity, and the greater the proportion of the entire power used by the mine, that is devoted to an electric hoist, the poorer will be the efficiency of the whole system, for the maximum amount of power required by the hoist must be purchased and brought to the hoist motor ready for consumption at any time. Of course, this loss will be obviated whenever storage batteries become possible for everyday use.

The next surface motor of importance around a mine will be the mill engine, which as a general rule has a constant load. It is only in the smaller mills that the power required for the rock breaker is intermittent, but in such a plant as we have been considering, the rock breakers will probably be of such size that they can run continuously from the ore bins, which will render the total power required from the mill engine a constant.

In this case for compressed air the engine will probably be, for ordinary purposes, a straight-running simple Corliss engine, using reheated air. If the mill requires a considerable power, it would be advisable to install a tandem compound Corliss engine, where the air will be reheated twice, as in the case of the hoisting engine.

Compressed air can claim no particular advantage over electricity in its economy for driving this constant load, nor, for that matter, over a high efficiency water wheel or a compound condensing steam engine. The honors are practically easy all along the line.

Our general system being compressed air, therefore, there is no loss or disadvantage in using it for the constant load. The same course of reasoning will apply to engines which may be used for driving Cornish pumps from the surface, or any other constant load requirement, such as driving fans or tramways. For intermittent work, such as a sawmill, in connection with a mine, compressed air would have the same economy with a properly designed motor as for the hoist.

Outside of the requirements heretofore mentioned, the only other required service would be for furnishing lights. For an ordinary mine 10 to 15 horse-power would readily supply this. Compressed air, of course, will have to be transformed, through an air motor and dynamo, into electricity for furnishing lights, and this naturally must be at considerable loss, and of course in this instance furnishing the electric current direct would be very much more economical, but the amount of power required for this service is so insignificant, in reference to the balance required by the mine, that it need not be seriously considered.

For underground work there are practically but three kinds of work required—hoisting from winzes, running of rock drills and pumping.

Owing to the fact that, as a general rule, it is not desirable to place large or expensive hoisting plants under ground, the character of the engines used is not very economical,, but the work is so intermittent in its character—much more so, as a general rule, than the hoist on the surface—that even these uneconomical engines can be operated with compressed air for much less than by electricity. In many cases it is desirable to reheat this air, which can be done with perfect ease, either by means of an externally fired furnace, using either wood or coal, where an old shaft or a proper system of ventilation will take away the gases of combustion, or the air may be heated by an internally fired furnace, in which coke is placed at proper intervals of time in sealed chambers made to withstand the air pressure, and through which the compressed air passes, furnishing oxygen for the combustion.

It is always well in installing underground hoists of all kinds, to place in close proximity as large a reservoir capacity as possible.

For underground pumping, ordinary direct-acting steam pumps, using air for actuating them, are the most uneconomical machines that can possibly be employed in the use of any power, and should never be used, unless their utility more than counter-balances their wastefulness of power. In sinking pumps, especially in confined spaces, there is scarcely any other form of pump that can be used with any degree of satisfaction, and utility is the only thing to be considered. A power-driven pump would be undesirable under such circumstances. For larger spaces, compound direct-acting pumps for sinking pumps, and even station pumps, have a reasonable degree of economy, but would at the same time require an element of utility to be considered in order to counterbalance the economy of an electrically driven station pump. The latter,

however, possesses so many disadvantages in the fact that gears are nearly always introduced for the reduction of speed and are subjected to tremendous wear, that their use is limited.

For a properly operated mine, having a considerable quantity of water to pump, a station pump, with compound engines using reheated air, will give the greatest economy. When it comes to the subject of rock-drilling, which forms, as a general rule two-thirds of the power required underground, at present compressed air has the field all to itself, and here utility alone is considered, for rock drills are as uneconomical in the use of air as a direct-acting steam pump; still they do such a tremendous amount of work in comparison to the cost for operating them that their economy is measured only in the amount of rock or ore which they are instrumental in extracting, and not in the power which is required to drive them. It is evident, however, that it will take less power to furnish air for these machines if such air is taken directly from the transmission main than if it were furnished at the surface by water-power or electrical or steam motor. Besides, a considerable portion of the cost of furnishing compressed air to these machines is offset by the pure air which is furnished to the miners under ground and the readiness with which it blows the smoke caused by blasting from the various underground workings. For underground work it is also valuable in case of accident. Many an air pipe leading back into a drift, a portion of which has caved and imprisoned miners beyond, has not only furnished them pure air but at the same time these pipes have given a means of communication with those outside.

The use of air around a mine is also in the nature of an insurance, especially where a mine has the apparatus for using steam. Air being used practically under similar conditions to steam, can be utilized in the motor or engines, and, in case anything should happen to the pneumatic system, it will only take a few hours to close off the proper valves, fill the boilers with water, get up steam and proceed as before; whereas it is impossible to use the electrical apparatus with anything but electricity.

As far as first cost is concerned, the average of a number of costs of installation which have come to my knowledge show me that the air plant is from twenty-five to fifty per cent cheaper, depending upon the nature of the installation, the size of the power and the distance of the transmission.

As a general rule, the ordinary free gold milling mine in the State of California on a working basis would require motive power, divided up nearly as follows: 25 per cent for the mill, 32 per cent for the hoisting, 5 per cent for direct-acting pumps, 10 per cent for station pumps, 23 per cent for rock drills, and about 5 per cent for lights.

Allowing that electricity to the amount of this 100 per cent has to be purchased to operate this mine, using compressed air according to the manner that I have mentioned, I believe that there would be required about 74 per cent in comparison to the electrical requirement, divided up as follows: 25 per cent for the mill, 10 per cent for the hoist, 3 per cent for the direct-acting mill, 13 per cent for the station pumps, 16 per cent for the rock drills, and 7 per cent for the lights, making a total of 74 per cent.

My opinions in the matter are somewhat borne out by the experience of electrical engineers, themselves. For instance, in an article written in a pamphlet called "Stone," the following remark is made:

"You may not know that Mr. Thomas A. Edison, the greatest electrician of the present time, has been for the last two or three years experimenting on a mammoth scale, at Ogden, New Jersey, in which he quarries a low grade of iron ore, hoists and conveys the same by means of two cableways, delivers to the crusher, and after being crushed the material is gradually reduced to a powder, when by electrical process the particles are separated from the particles of stone, the iron particles being then compressed in the form of bricks and sold as a high-grade iron ore.

"Mr. Edison's quarrying operations involve the use of hoisting engines, drills, pumps, etc. Mr. Edison tried the Edison drill, which he told the writer he never saw until it was delivered to his quarry. The electric drill is being thrown out and the steam drill employed, though electric motors are still used somewhat in the mill. On all their hoisting apparatus steam hoisting engines are employed. Now, it seems that until Mr. Edison can successfully use electricity in quarrying operations, it is useless for others to waste their time experimenting in this line. For anything like intermittent hoisting with a derrick, the electric hoist is not nearly so economical or efficient as steam hoisting engines."

It has been found recently at Jerome Park, where a very excellent compressed air plant has been installed by an Eastern compressed air engineering concern, that they are operating hoisting engines and rock drills very much cheaper by compressed air than they formerly did by steam.

Statements are made, which I have no means of verifying, that it is done with one-half the coal formerly required when steam was used direct. The contractor is making a large excavation, covering probably a square mile in extent, for a reservoir. He has established in the center of the work a 500 horse-power air compressor, and is driving fourteen hoisting engines and fourteen rock drills at various parts of the work, and reheating the air prior to its use in the hoisting engines. The economy of this plant is so marked that at the present time a contractor in Philadelphia is installing a similar plant for work to be performed there.

These results seem to point to the fact that where steam, directly generated, cannot compete with compressed air it is useless for any other power to try to do so under the same conditions. It all lies in the fact that the work is intermittent and that is the principal claim made on this present occasion, that in determining the character of the power to be selected for any kind of an operation many things besides the efficiency are to be considered. Very frequently a compressed of the apparatus at full load and constant operation, air or water-power plant, capable of storage capacity, would be more economical to use at a constant load efficiency of fifty per cent than any other power at a constant load efficiency of ninety per cent. It is like the cost of a manufactured article—it matters very little what the rate of wages paid, provided the amount of wages which enters into the cost of the product be satisfactory. So it is in a power proposition—it is not the efficiency of five minutes' operation, it is the total cost covering twenty-four hours.

From an engineering standpoint, if one were asked the most economical steam motor to operate an electric steam railway plant, one would say, a compound

or triple expansion Corliss engine, running condensing. But this depends entirely upon the cost of the coal, for it has been proved in parts of the United States where coal is as cheap as $1 per ton, that the difference in interest and depreciation between the condensing plant and the simple high-pressure plant will more than offset the difference in the cost of fuel, even if the coal cost $1.40 a ton. This is an instance where high efficiency engines are not engines of great economy, and I have been particularly emphatic upon this point, because compressed air has suffered much on account of improper comparison with electricity, in this manner.

We all know that there have been constructed electric generators and motors that will give an efficiency of from ninety-two to ninety-five per cent at full load, while compressed air generators and motors fall below these figures in mechanical efficiency, but in practical economy for such work as we have had in consideration, I claim twenty-five per cent superiority in economy over the electrical installation. Mechanical operations are not conducted for amusement but for profit, and that operation which produces equal results with another, for a less monthly or yearly cost, labor, material, fuel or power, interest, depreciation, etc., being all given their proper value, is the more economical.

I claim that comprssed air, for intermittent work (which is fully fifty per cent of all work done by motors), has no rival for general economy or utility, and particularly is this true for mining work. It must always be borne in mind that economy in compressed air depends upon reheating, and then expansion, and my remarks are not directed toward that class of compresed air motors which use cold air or air at full pressure. Utility very frequently overbalances considerations of economy or efficiency, as may be illustrated in air brakes which are attached to the locomotives throughout the world. These air brakes are most uneconomical in the use of steam, using it practically at full pressure, and are about the same class of motors as the direct-acting pumps which have an efficiency of only about twenty per cent as compared to a high-class steam motor. I have heard it stated that there are 20,000 of these air-brake motors working in the United States alone, absorbing about 10 horse-power each, making 200,000 horse-power devoted to this appliance alone, which completely overshadows all the rest of the compressed air installations in this country in magnitude, and yet no one hears of anyone attempting to replace this very inefficient motor with any other more efficient appliance for generating compressed air, for its utility is such and there is so much dependent upon it, that economy is a secondary consideration.

At the present time in the Eastern States there is a very marked revival of interest in compressed air, with reference to its application to street-car motors. A considerable amount of money has been expended in experiments by two companies in New York City during the last year, which has resulted so favorably for compressed air motors that many street railway companies throughout the United States are preparing to make experiments on their roads in order to determine the relative merits for their particular purposes of compressed air as against the cable or electricity.

Within the last month a car has been running in the streets of Washington, D. C., but I have not had any reports from it as yet. About this time the most elaborate experiment of all, namely, the running of a train drawn by a compressed air motor, will start from Rector street, w York City, and run to Fifty-eighth street, on t Sixth avenue elevated road, at regular intervals. A 250 horse-power plant has been installed at a convenient point near one of the terminals, and every precaution has been taken to insure the successful termination of this trial. This plant will undoubtedly be open to public inspection, so that all may satisfy themselves.

The struggle between the electric and the compressed air systems for supremacy will not, as I have indicated before, be based upon the efficiency of engines or motors, but upon the general economy of the plant. This can be readily appreciated when we consider actual figures in connection with the operations of these plants. For instance, in a recently published report of the operating expenses of twenty electric roads in Connecticut for 1896, the average cost of motive power and line repairs per car-mile was 3 cents. The compressed air system, with coal at $2.75 per ton, water at $1 per thousand cubic feet, or waste, the labor, repairs and maintenance of power plant, depreciation and interest on the cost of the entire power plant, makes the cost per car-mile, of the motive power, $0.023. In either of these plants the cost of coal per car-mile does not exceed $0.005, or an average of about one-fifth of the cost of the motive power, so that one can readily see that engines and motors of even medium economy would not affect the cost of the motive power to any perceptible extent, provided that the cost of maintenance was low—in fact, maintenance is the principal expense in the motive power department, and what everybody is looking for at present is a system which places the cost of maintenance at the very lowest point.

My remarks become less true as the price of fuel increases, until, of course, there would come a point when the price of fuel would be the principal consideration. I should judge that on this coast we were about midway between these two factors.

MACHINERY IN TALL BUILDINGS.

American enterprise in the erection of big buildings for business purposes has become known the world over, and for the engineer these piles of stone and metal hold varied and important interests. From the beginning of their foundations his services are indispensible, and after completion the maze of machinery which they hold continues to require them, for advice as well as management. Like the modern ocean steamship, the large business building of the present day harbors, deep down, out of sight of all but the operating force, a magazine of power of which the proportions are but vaguely guessed at by the multitude above. Boilers, engines, dynamos and pumps there are in bewildering numbers, supplying heat, light and power to the upper regions through miles of pipe and wire; humming blowers and exhaust fans both supply and abstract air through many-branched ducts for ventilation purposes, and ice and refrigerating machines, too, often must have a place, all helping to make up a machinery equipment of magnificent extent. One measure of this—perhaps as good a one as can be given—is the money value of the outfit. In one building, a hotel structure, now going up in the city of New York, the cost of the steam power, heating and ventilating plant will be in the neighborhood of $250,000, while that of the electric lighting installation will figure up to even more, $300,000.

Hydraulics

THE GOVERNMENT OF WATER POWER—II.

By Mark A. Replogle, Engineer.

(Concluded from Page 49.)

"Capacity of plant for stored energy," the third element to be considered in the government of water-power, is perhaps the most important factor, and often receives the least consideration. It is too often a chance factor. The capacity of the plant for stored energy may be easily understood. The following comparison partially illustrates the idea: To reduce the walls of a fortress may require a gang of laborers to use their united energy for several months of time, yet a few hundred pounds of steel in the form of a projectile fired from a cannon can in an instant be charged with energy enough to carry it a number of miles, and at the end of its flight it yet may retain power enough to reduce the fortress in a moment of time. This principle of storing energy in material in motion is the fundamental principle of all speed government.

If the above cannon ball were forged into a fly-wheel and could be revolved on its axis with such rapidity that its average speed equaled the velocity that it had when fired from the cannon, it would contain the same quantity of energy, and this quantity might amount to many thousands of foot-pounds. In speed regulation this stored energy can be used to supply the demands for power until gravity can generate it; in like manner this capacity for energy storage can absorb power when the load has decreased until the power supply can be shut off. It can readily be seen that any and all of the moving or revolving parts of a power plant are store-houses for energy, and their capacities depend upon their weights and velocities. The physical laws governing the quantities of energy under the various conditions are well understood by our scientists and engineers; hence, advantage can be taken of them in the construction of our modern water-power plants.

The careful steam-engine builder has learned by experience that he must provide this power-storage capacity in his engine, and he varies it according to what is required of it in government. There is no doubt but that the use of flywheels on engines is a result of experience in trying to maintain even speed, and that their prime purpose is to carry any change in load until the power supply from the boiler can be brought into play to carry the new load and to supply the power that the fly-wheel gave out in advance of it. The time required to get gravity effects is always greater than the time required to get the expansive effects of steam; therefore, the capacity for power-storage should be correspondingly greater in water-powers if the same efficiency of regulation is required.

The momentum of water-power plants is often very much less than that of steam-power plants, and this lessens the possibilities of government to an extent determined by the changes in load, the time required for gravity to act, and the quantity of power stored in the moving parts of the plant. This factor, power-storage, cannot be too carefully considered. It is the factor above all others that the designer of a water-power plant can most easily control. It is the one factor that can be varied to counteract all the bad effects of all the others; therefore, an intelligent application of it should be made in all water-power plants where good government is important.

The last factor to be considered is the "governor." The governor is often considered to be the most important factor in the government of a water-power; but it is only one of the important factors, and if it is a perfect machine it may still be limited in its efficiency by the three above discussed factors. A good governor can only play the part of an honest judge: Evidences of strife in the form of changes in load are placed before it; facts of design and construction are placed at its disposal; the unerring laws of physics are brought to bear on each new case, and honest judgment is meted out in the form of speed or government of the plant, and no jury or supreme court can set aside the verdict.

A good governor must move the wheel gates as fast as gravity will respond in giving the proper velocity to the increased quantity of water required to supply the demand made for power. If it operates too fast, the results are detrimental to good government. The governor must have wrought into it the principles that co-operate with the power storage of the plant. It must be so designed and constructed that it will stop moving the gates when they have reached the proper position to supply power for the new condition of load. A good governor must make its judgments quickly and accurately, always returning the speed to normal after correcting the inertia and momentum effects of the change in load. A good governor should also be simple in design and mechanism; otherwise, it will be an expensive and unsatisfactory part of the plant. The constant and reliable duty expected of a governor requires it to be a powerful machine; the positive and quick judgments it must make requires it to be sensitive and delicate in some of its parts, and the importance of its position in a plant requires it to be symmetrical in appearance and mechanically perfect in its construction.

The possible regulation in a water-power plant need no longer be a matter of experiment and doubt. The designer of such a plant need no longer be in darkness as to the government of his plant until he has experimented with several governors. He can design his plant for any desired efficiency of regulation, and a properly designed governor can govern it.

All plants already built are capable of a certain degree of regulation. If this degree is not satisfactory and figures show that it cannot be improved, then further calculations will show positively what changes must be made in order to obtain the desired results.

In conclusion, it should be said that if the limitations of water-power government were investigated more carefully, there would be less doubt concerning the results in any particular case. Many of our conservative engineers who have not taken time to make these investigations, have still some doubts regarding reliable and automatic government of water-powers; but the results where these limitations have been intelligently calculated and the proper remedies applied, prove beyond all doubt that any desired efficiency of government can be provided for, even to the finest steam-engine practice.

WATER POWER UNDER HIGH HEADS.

In the Engineering News for July 8th, appears a long editorial discussing difficulties in the use of water power under high heads and which, being opportune

with the publication of Mr. Replogle's article preceding and with the unusual interest that the development of such plants has awakened on the Pacific Coast, is reproduced below in abstract:

In an article in another column,* Mr. John Richards, of San Francisco, gives a brief account of some of the difficulties which have been experienced on the Pacific Coast in the development of water power under great heads. To get a clear idea of just what these problems are, let us take a practical example. Suppose we have a pipe 12 ins. in diameter and 100 ft. long delivering water to a water motor. Suppose the pipe is vertical, so that the static head is also 100 ft. and that the water is flowing through it at the rate of 6 ft. per second to supply the nozzle or contracted orifice at the lower end through which it issues against the buckets of a wheel. The weight of water in that 100 ft. of pipe will be 4,900 lbs., and its velocity of 6 ft. per second is equivalent to nearly 4 miles an hour, about the rate of a rapid walker. The energy stored in this moving mass of water is

$$W \frac{v^2}{2g}$$ — equal to 2,750 ft. lbs. At this velocity the pipe will deliver 277 cu. ft. per minute, weighing 14,790 lbs.; and as the head (neglecting loss by friction) is 100 ft., the total useful effect will be 1,479,000 ft. lbs. per minute. Dividing this quantity by 33,000, we have the horse power of the fall at 45 h. p. Suppose that the load on the motor is reduced to 15 h. p. That means (neglecting the friction of the motor itself) that only one-third of the amount of water should be applied to the wheel. Its velocity in the pipe will then be 2 ft. per second instead of 6 ft., and the energy of the mass of water in the pipe will be only one-ninth as great, since this varies with the square of the velocity. That is, it will be only 305 ft. lbs. instead of 2,750 ft. lbs., a decrease of 2,445 ft. lbs. Now, something must be done with this 2,445 ft. lbs. in order to reduce the velocity of the water to the extent we have supposed. It is certain to expend itself somewhere. Were we instantly to close the orifice, it would expend itself in tearing the pipe open. If we close the orifice only partially, the inertia of the water immediately raises the pressure at the lower end of the pipe and the water issues with greater velocity than before. This added velocity represents additional work, the source of which is the inertia of the water in the pipe, and as the inertia is gradually absorbed, the velocity falls back to its former amount.

The inventors of water wheel governors have been exerting themselves in every way possible to secure quick moving valves and valve motions in their attempt to secure close regulation of speed. We do not say that they are not working in the right direction, but let us suppose that some one should really devise a governor so perfect that at the same instant the load on the wheel was reduced to one-third, it would close the gates admitting the water to the wheel to one-third their former opening. Let us suppose that this movement is actually instantaneous, and see what would happen in that instant. In the first place it is clear that the water in the pipe could not change its old velocity of 6 ft. per second instantaneously, hence for an instant the same amount as before must be delivered through an orifice one-third as large, or at three times the velocity. The old velocity was that due to a static head of 100 ft., or 80 ft. per second. The new velocity will be 240 ft. per second, which corresponds to a head of 900 ft., or a pressure of 391 ft. per sq. inch. As the same amount of water is issuing as before, but under nine times the head, the work done to the wheel will be nine times as great. Of course, this high pressure on the pipe line and increased work on the wheel are merely for an instant. At the same instant the inertia of the water in the pipe begins to be absorbed the velocity begins to fall off, and with it, of course, the quantity of water delivered to the wheel. If the velocity and delivery which we found above were to remain constant, it would be only 1-82 of a second before the 2,445 ft. lbs. of inertia, which appear when the velocity of the water in the pipe is changed from 6 ft. to 2 ft. per second, would be absorbed.

The supposition we have made is not a practical possibility. No valve can be opened or shut instantaneously, and as a matter of fact, in all water wheel governors the large size of the valves makes their closing very slow as compared with the valves of a steam engine, for example. The above discussion shows, however, that even if this could be overcome, the difficulties in close regulation of water wheels would not be at an end. The first effect of the partial closure of a water wheel gate taking its flow from a long conduit is an actual increase in the work done on the wheel, and conversely, if with an increase of load the gate is slightly opened, the first instantaneous effect is to reduce instead of increase the work done on the wheel.

These are correctly spoken of as instantaneous effects. In the case of pipes of moderate length they may never become practically noticeable. With very long pipes, in which water flows at high velocity, they may cause a vast amount of trouble if they are not foreseen and provided for.

The practical rules which may be easily deduced from the foregoing discussion are two. Since in every water power plant it is desired to reduce the difficulties from irregular governing of the motors and excessive pressures on the pipes as much as possible, the engineer should endeavor (a) to make the length of the pressure pipe as small as possible; (b) to make the velocity in it as low as possible by making the diameter as large as possible.

In almost all cases the increased cost of a pipe of larger diameter will make it not feasible to increase the diameter merely for this reason, but it is well for the engineer to understand that this is a desirable end to be attained.

In the direction of reducing the length of the pipe much more can be done. The engineer, for example, can often take his choice between running a pipe from the source of supply directly to the place where the power is to be utilized and running either a pipe or an open channel on the hydraulic grade line to a point as near to the power house as possible, and from there running a pipe to the power house on a steep grade. When this choice is offered to an engineer, the plan that gives the shortest length of pressure pipe should be adopted.

It is often supposed that the pressure at the lower end of the conduit is the important item as respects the difficulty in governing water wheels, but this not really the case. The pressure has a practical influence as respects the weights of the gates to be moved, but so far as the inertia of the water is concerned, which has to be taken care of when a change in the load of the wheel occurs, it is the length of the pipe and not the head of the water at the exit that is the important factor.

Let us examine the different methods proposed or possible for solving this problem. The simplest way, doubtless, is to maintain a uniform flow of water in the conduit, and govern the wheels by deflecting the nozzles slightly when the demand for power falls off. The objection to this is that it is wasteful of water. The amount of water used is always equal to the maximum load.

A method which gives good results in the case of closed turbines is to govern the flow by throttling the escape from the wheel. It will be seen that the inertia which has to be disposed of when the flow in the supply conduit is checked is, in this case, not applied to the wheel at all, but is expended in giving velocity to the water escaping from the wheel. But this method is not applicable at all to open bucket or impulse wheels, and it has the disadvantage that, except when the wheel is working at full load, a considerable amount of power is wasted.

The attachment of air vessels to the supply conduit is a common mode of solving the problem, but the difficulty is that, unless an air vessel is of enormous size, it can absorb only a very small amount of power under the conditions existing in a water power plant. It must be remembered that an air vessel operates only

* The substance of Mr. Richards' article is embraced in the issue of the JOURNAL OF ELECTRICITY for October, 1896, describing the Cobb relief valve.—EDITOR JOURNAL OF ELECTRICITY.

by the increase in pressure in the conduit to which it is attached, and the work it stores is only that required to compress the volume of air which it contains from its initial to its final pressure. But to fulfil the requirements of good governing of the water wheels, the pressure cannot be allowed to increase very much above the normal.

The proper use of an air vessel (and its value for this purpose is unquestionably great) is to take care of the inertia of the flowing water when a gate in a long conduit is entirely closed. As every experienced hydraulic engineer knows, the very greatest care is necessary in closing a gate in a long conduit to prevent a "water ram" that will burst the pipes. In a conduit under pressure, the metal of the pipe has very small power to resist shock. But when the gate is closed slowly, the velocity is reduced until the amount of energy in the flowing conduit, which the air chamber has to absorb when the escape of the water is finally cut off, is very small.

Mr. Richards, in his paper above referred to, states that when the flow in a long conduit is suddenly checked, pulsations of pressure are set up. The foregoing study of the actions of water under such conditions makes one cause of these pulsations plain. Suppose we have a water wheel with a governor which operates by throttling the flow of water to the wheel, the almost invariable practice. Suppose the load on this wheel is reduced one-fourth. The speed increases and the governor begins to close the nozzle; this raises the pressure in the pipe and, as we have already seen, actually increases for a moment the work done by the jet on the wheel. The effect of this on the already underloaded wheel is to increase its speed still more, causing a further movement of the governor, and another increase in pressure. The net result of the action is to cause the governor to close the nozzle until the flow is reduced below what is necessary for the load on the wheel. Then the speed of the wheel is reduced below the normal and the governor begins to open the throttle valve, which causes a drop of pressure in the conduit, and the same cycle is repeated until an equilibrium is finally reached. These occurrences, of course, take place with great rapidity, and constitute that rythmic pulsation which is described by Mr. Richards and also by the writer* who describes the Fresno power plant in another column.

The reader who has followed the above discussion can now form an intelligent opinion as to the merit of the device of Mr. E. S. Cobb, described in Mr. Richards' paper. It appears to us to be an excellent device, and likely to prove effective if properly designed. We desire to call especial attention to the waste valve of this device, which appears to us likely to prove the best method for controlling the flow in long pipes and solving the difficulties in governing the speed of wheels, and in controlling the pulsations and shocks in the pipe to which we have referred. Such relief valves should be proportioned to the size of the pipe they control, and should be located as near to the nozzle of the pipe as practicable. They should be so loaded as to open automatically when the pressure in the conduit rises somewhat above the normal working pressure, and would then act to prevent the further increase of pressure in the pipe. The water wasted through them would be comparatively small in amount and would furnish, we believe, the cheapest and simplest way of taking care of the energy that appears when the velocity of flow in the conduit is checked.

In any case it is true that to secure good governing these valves would have to open at a pressure lower than that due to the static head on the pipe. But it would be a simpler matter in any such case to make part of their load removable, so that when it is desired to entirely shut off the flow there may not be a waste of water through these valves.

In conclusion, the reader cannot fail to have perceived that to secure good governing in hydraulic motors working under high pressures, sufficient time is an absolute essential. We cannot suddenly change the rate of flow in a long conduit, but we can do so gradually without difficulty, and the best thing that can be done when a water wheel must be driven from such a conduit to carry a rapidly varying load is to furnish a reservoir of energy in the shape of a heavy fly wheel on the water wheel shaft. By this means the changes in the speed of the water wheel may be made so gradual that a similar variation of flow can be made in the conduit without causing either excessive variations of pressure or waste of water.

While all our foregoing discussion has referred solely to the problems encountered when water power is developed from long conduits, the use of fly wheels in any water power plant will be found to be of great advantage. While the engineer has no difficulties with pulsation of water hammer to encounter when a turbine takes a supply directly from a fore-bay, the difficulty in quickly moving the gates of the wheel when sudden changes of load occur makes the steadying effect of a fly wheel of great value here as well.

Cast iron is very cheap and the maintenance of a good many tons of it in the shape of fly wheels is a very small item. We believe the engineer entrusted with the design of hydraulic power plants who is liberal in his provision of fly wheels will find them the best insurance against difficulties of the class which we have described.

* Geo. P. Low in the "Fresno Edition" of the JOURNAL OF ELECTRICITY for April, 1896. Reproduced without proper credit in "The Engineer," London.—EDITOR JOURNAL OF ELECTRICITY.

Fraternal

THE A. I. E. E. GENERAL MEETING.

The fourteenth General Meeting of the American Institute of Electrical Engineers will be held at Greenacre-on-the-Piscataqua, Eliot, Me., on July 26th, 27th and 28th.

The opening session will be held on Monday, July 26th and the following papers will be presented:

"The Precision of Electrical Engineering." Inaugural Address, by the President, Dr. Francis B. Crocker, of New York City.

"The Alternating Current Induction Motor," by Charles Proteus Steinmetz, of Schenechtady, N. Y.

"A New Form of Induction Coil," by Prof. Elihu Thomson, of Lynn, Mass.

"Effect of Heat Upon Insulating Materials," by Putnam A. Bates and Walter C. Barnes, of New York City.

"The Effect of Armature Inductance upon the Electromotive Force Curves of an Alternator," by Prof. W. E. Goldsborough, of Lafayette, Ind.

"Electric Metering from the Station Standpoint," by Caryl D. Haskins, of Boston, Mass.

"Development of the Fire Alarm Telegraph," by Adam Bosch, of Newark, N. J.

"Electrical Traction.—Notes on the Application of Electrical Motive Power to Railway Service, with illustrations from the Practice of the Metropolitan Elevated Road of Chicago," by M. H. Gerry, Jr., of Chicago.

"The Cost of Steam Power," by Horatio A. Foster, of Buffalo, N. Y.

"Efficiency and Life of Carbons in Enclosed Arc Lamps," by W. H. Freedman, of New York City.

"Armature Reactions in a Rotary Transformer," by Prof. Robert B. Owens, of Lincoln, Neb.

"Recent Applications of Storage Batteries to Electric Railways," by Herbert Lloyd, of Philadelphia.

"The Economy and Utility of Electrical Cooking Apparatus," by Prof. J. P. Jackson, of State College, Pa.

Historical

A LESSON IN DYNAMO DESIGNING.

He was a rather crochetty old fellow, and as he bent over his work, the shop-foreman observed that he was at once the most crabbid and the most interesting man about the works. "Sometimes," said the foreman, he'll snap your head off if you ask him the most civil question; at other times he'll talk away most agreeably. As for a workman, there's no better in the country and, by the way, he was with Ball when the Ball dynamo was invented."

Here, then, was an opportunity, perhaps, for enlightenment concerning that much-talked-of, that declared to-be-impossible, that universally-derided, yet altogether successful, that so-called "unipolar," Ball dynamo, and the possibility of learning, even indirectly, the views of the inventor, made the irascability of the old man to be no barrier. Indeed, at the mention of "Ball dynamo," the old man's irritable mein vanished into one of affable retrospection. Plain, unpretensious and straightforward as to the English used, the old mechanic told how the Ball dynamo became a reality and, were the truth known, perhaps the humor of this narrative may relate between its lines, the fact of many an invention that has brought both weal and fame to its originator.

"You want to know how Ball came to invent that dynamo, eh? Well, sir, I'll tell ye," he replied. "It was just this way, and after I'm done tellin' ye, kind o' make up your mind if 'twas invention or what. You see, Ball wan't no electrician then. He wor a machinist like me now, and when he brought out his dynamo that everybody laughed at an' said would'nt work, he was running a machine shop. In them days, everybody was building dynamos and he thought he'd build one too. So he just put up an arc machine with four field coils,, 'consequent pole' type they call it, and had the armature shaft run through the yokes parallel with the fields. She worked all right with a few arc lights, but he thought it didn't run enough lamps, so he just run her faster and she run more lamps, then he run her faster yet, and the blamed armature busted.

"You see he wa'nt no electrician, he was a mechanic, and when a mechanic has a machine break down on him, he's going to find out the reason why. So he just took that armature and sawed it right through crossways of the shaft, you know, when he see that the inside wires next the core were the ones that got hottest and then he says to himself, says he, 'if them blamed wires weren't wrapped on so thick, or if the machine was fixed so as to let the air get at 'em more, she'd be better off. So he makes two armatures and puts 'em on one shaft and lets each armature have two pole pieces so they'll get more air and then let her go, and, I tell ye, she started off fine. Then pretty soon he kept on adding lamps and driving her faster, thinking he'd ought to get more lamps out of her, when up goes both armatures in fire and smoke.

"That was hard luck, but Ball still thought the idea was all right and we were set to work and made the armatures over new, but before we got the machine put together again something interfered and Ball got kinder out of the way of tinkering with the electric business and the parts of the machine were left laying around the shop. Finally one day, maybe six months or a year afterwards, after they had had a directors' meeting and all the directors were standing around the shop talking, one of 'em said 'Say, Ball, what's the matter with your arc light dynamo that you was going to do so much with?'

"'The dem thing ain't no good, that what's the matter with it,' says Ball.

"'Why ain't it no good?' says he.

"'Just wait a little while and I'll show you,' says he.

"Then they all went down to the shop and Ball told us men to put that dynamo together quick, and we hurried like the old Nick was after us, and in a little while we had her rolling bully.

"'You see,' says Ball to them directors, 'she'd ought to carry more lamps, but she won't; now watch her.'

"With that, Ball put on more lamps and more steam and she carried 'em. Then he put on some more, and then some more, and I'm blamed if she didn't carry 'em all fine.

"'Gee whillikins,' thought I, 'what's the matter with her anyhow? She never carried so many lamps as that before.' Ball, too, seemed puzzled; then he gave her a look as much as to say 'I'll bust her anyhow' and ordered us to slap on another batch of arc lamps and threw the valve wide open. The old machine just tore around like wild, but she carried the lamp all right though. But, by and by, bang went an armature and the jig was up.

"'There,' says Ball to the directors, 'that's why the dem thing ain't no good.'

"After they was gone, I kept scratching my head and thinking how fine she carried that big load and what a fool Ball was to burn her up because he had told the directors she was no good and didn't like to take water. I felt kinder bad about it and wandered back to the machine to see how she had busted this time.

"Well, sir, begosh, would you believe me, Ball had hurried us men so in setting up the machine that we plumb forgot and left off one of the pole pieces so that one armature had only one pole piece and the other one had two. And, sir, the armature that was burned out was the one that had the two pole pieces, and when Ball saw it he just said to himself, 'by golly, I'll give each armature only one pole, blamed if I don't'—and he did.

"That was how Ball's dynamo was invented. He didn't know nothing about electricity, nothing at all; he was a mechanic like me, but his machine is a good one even if it is built in a way that electricians said wouldn't never work."

THE NIAGARA FALLS CONVENTION.

The twentieth annual convention of the National Electric Light Association, held at Niagara Falls, on the 8th, 9th, and 10th of June, was considered by the delegates to be one of the most successful gatherings in the history of that organization. A number of very interesting papers were read and discussed. The attendance was unusually large and the exhibitions of electrical apparatus made by the different supply houses throughout the country was of more than ordinary completeness. The exhibition of the Westinghouse Electric and Manufacturing Company was especially attractive, owing to its completeness and the many interesting features which it contained. The Company had on display several Induction Motors, Direct Current Generators, Alternating Current Generators, Switchboard Apparatus, Lightning Arresters, Converters, Arc Lamps and Incandescent Lamps. The latter forming an exhibit made by the Sawyer Electric Company, of Allegheny City, Pennsylvania.

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EDITORIAL.

CALIFORNIA LEADS THE WORLD.

The rapid advance which is being made in California in the use of higher and yet higher potentials in the electrical transmission of power bids fair to far surpass the most sanguine estimates of conservative thinkers. As recenty as September last, Dr. Louis Duncan, in his presidential address to the American Institute of Electrical Engineers, discussed the possibilities of long distance electrical transmission and presented a tabulated list of the principal transmission plants in the world, observing that "the longest transmission is at Fresno, Cal., the distance being about 35 miles. The highest alternating voltage used is 13,000 volts at Zurich, Switzerland. The highest direct potential is 15,000 volts at Brescia. All of these plants are working successfully, and this fact will lead to still longer transmission and higher voltages. No limit of either distance or potential has yet been reached. If we consider the record of the present transmission plants, we can safely say that it would not be going outside of the safe limit of development to transmit at least 50 miles at a potential of 20,000 volts, provided the energy could be delivered at such a price as to be considerably lower than the cost of a corresponding amount of energy obtained from a steam plant."

But ten months have passed since the rendering of this eminent opinion, but this brief period has seen the complete success of the Westinghouse 15,000 volt alternating current transmission of the Central California Electric Company into Sacramento, Cal. The laurels for the longest distance transmission have passed from Fresno to Ogden, Utah (36 miles) and now contracts have been awarded to the General Electric Company by the Southern California Power Company for the transmission of about 4000 horse power from the Santa Ana River to Los Angeles, a distance of 81 miles, the potential to be employed being 33,000 volts, alternating current. Not a well-grounded doubt has been expressed that the undertaking will not be crowned with success.

It is indeed a happy combination of circumstances —this abundant water power, this high-priced fuel, this immunity from snow, sleet and humidity—that makes the great valleys of California the proving grounds of the electrical transmission of power. More than this, capital invested in electrical transmission enterprises in California is not ventured as in less favored localities where the elements, as if filled with malicious envy, do their uttermost to balk and thwart the efforts of engineering skill.

The eyes of the electrical engineering world have been, and are, and will be. centered on the thrice-favored valleys of California, the nursery where transmission enterprises are reared and develop from experimentation to success.

LUCK IN DAILY LIFE.

One of fortune's most favored sons has defined luck as being the ability to perceive opportunities and to take advantage of them, rather than as being "a favorable issue or combination of events" tending to good fortune. The lucky man in the eyes of the world, is a creature of chance, sometimes without ability or worthiness, but who has stumbled into fame or a bountiful share of life's good things. They say that his striking a bonanza was purely accidental, overlooking the years of application that led him to successfully prospect it; or that by mere accident he was mounted to a lucrative sinecure, quite unmindful of the assiduity that was his stepping stone, or that he happened to hit upon an idea that had millions in it, as though ideas, like rare gems, were but to be picked up to bring the finder's own figure. Indeed ideas are one thing; their adaptation is quite another matter requiring the exercise of a special talent, either natural or artificial It may be pleasing to paint fortune as a fickle goddess, but it will be maintained that she bestows her favors as the reward of diligence, of perception or of experience. Luck ofttimes prevails, but its realm is not so broad as the popular idea leads to believe.

Man is by nature a fortune-hunter—a searcher for success, and how may his ambition for success best be satisfied? Surely not by deep-rooting the belief that luck is omnipotent—that it alone shapes man's destinies. It is wisdom to teach that luck is an artificial and not a supernatural creation, that it constitutes a reward for properly applied energy and that it is synonomous with the ability to perceive and take advantage of opportunities that daily arise.

The engineering field is most prolific of these opportunities. They are not obtrusive. They do not confront one as a reality but, subtile and evasive, they may easiest be found within the vast domain entered through the portals of knowledge. They pertain to all

subjects and they are as diversified as is human industry. The world is full of opportunities and the finding and availing of them is the watchword of every successful man.

In brief, it is not by any means true that luck always makes the man; generally the man who turns opportunities to his own advantage is the one whom the world considers lucky.

THE USE AND ABUSE OF TRANSFORMERS.

On another page of this issue begins the first article of a serial on "The Use and Abuse of Transformers", in which is brought out in a clear and convincing manner the various technical points, good or bad, which influence the standard of excellence of the transformer of today. The efficiencies attained in the leading transformers show them to be devices that have almost reached a point of perfection, but on the other hand, there yet exists and are largely used, transformers of such inferiority that their displacement by the latest types in the manner to be indicated in the serial, would in many cases effect an economy that would defray the cost of the change within a surprisingly short period.

If the article be criticized unfavorably it can only be on the ground that it deals particularly with transformers made by the General Electric Company, but nevertheless, such endorsement as is there given is well merited. More than this, however, the article speaks truths in almost every line that the prudent and painstaking station manager cannot digest too thoroughly. The article must stand endorsed, therefore, as the most clear, lucid and convincing yet written with a view of spreading education concerning the use and abuse of a most familiar device whose principles of operation is less understood by the general electrical public, than any other appliance known to the industry.

TESTING HIGH POTENTIAL INSULATORS.

The transmission companies of the Pacific Coast will find more to interest them in the paper read by Mr. J. G. White on "The Niagara-Buffalo Transmission Line" before the Niagara Falls meeting of the National Electric Light Association last month, than in any other contribution to that unusually instructive convention. Of especial interest is the section of the paper devoted to insulators and the croakers who have predicted the impossibility to insulate for 33,000 volts, as is proposed to be used on the line of the Southern California Power Company, will find little consolation in learning from Mr. White's paper that all the insulators in use on the Niagara-Buffalo line have been submitted to a test by the Cataract Construction Company, of 40,000 volts.

The method of making this test is described as follows: The insulators were set inverted in a shallow iron pan, in lots of about 20, the bottom of the pan being covered with an inch or two of water containing a little salt. A little of the same brine was poured into the pin-hole of each insulator, and into this was thrust a small piece of metal such as an ordinary iron spike or a small round zinc rod from a sal-ammoniac battery, this being connected to one side of the testing circuit, the other being connected to the pan containing the insulators. After the metal rod had been placed in the brine in the pin-hole of an insulator, the primary circuit of the testing transformers, specially built for the purpose, was closed and if the insulator was weak, this was quickly manifested by a series of sparks through the punctured porcelain. Experiments made with pure water and with brine showed that there was no difference in the results, but that any weakness was manifested a little more quickly with brine, besides which the salt imparted the characteristic bright sodium color to sparks, otherwise almost coloress and difficult to detect.

Mr. White's paper points out many interesting facts which were developed during these tests and are worthy of note. The insulating strength of porcelain depends almost entirely on the thoroughness of its vitrification and very little on its thickness, a thin China tea cup having successfully withstood a pressure of 60,000 volts, while a porous piece of porcelain two inches thick, was readily pierced by 20,000 volts. It is, therefore, practically unnecessary to test any insulator electrically which, when broken, will not pass a good absorption test, using red ink or other coloring fluid.

It is quite if not entirely impossible to puncture a glass insulator, even an ordinary pony telegraph insulator withstanding any pressure which can be applied, the last being determined by the pressure which will send an arc around the insulator. The objection to using glass insulators has been due to the difficulty in getting a well annealed and mechanically strong insulator of such massive design as is needed for this work and to the hydroscopic property of glass, which is not shared by porcelain. The first can unquestionably be overcome by care in manufacture. The importance of the second has probably been exaggerated in most calculations made in the past, due to an inadequate appreciation of the static effects of 10,000 volts in warding off snow flakes and drops of rain, and to a less extent of the rapidity with which water falling on such insulators is evaporated by the heat of the current leaking over the surface.

It is consequently, reasonable to expect that the use of glass insulators for high voltage lines will greatly increase with improved manufacture. Meantime, any lines erected should have the best obtainable porcelain, and every insulator should be subjected to test.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

TO APPEASE THE DEVIL.

The editorial appearing in the last number of the Journal discussing the difficulties that beset engineering undertakings in China has received significant confirmation in the report brought from the Flowery Kingdom by the British steamer Glenshiel, which recently arrived in San Francisco from the Orient. It seems that in the interior of China the coolies believe that the devil is responsible for the killing of people in railroad accidents and the new railway now being built into the interior from Pekin has filled some of the common people of the ancient empire with alarm, and it has been proposed that sacrifices of children be made to satisfy the devil and prevent him from killing people under the wheels of locomotives.

Many stories had been circulated before the departure of the Glenshiel from the Orient, and the number of children supposed to be necessary for the sacrifice varied from 2,000 to 10,000. Government interference, however, will probably prevent any such wholesale slaughter, but there is danger that some sacrifices will be made.

THE LONGEST ELECTRIC TRANSMISSIONS.

A contract for the transmission of power of the river running through the Santa Ana Canyon to Los Angeles and Pasadena, a distance of eighty-one miles, has been concluded between the Southern California Power Company and the General Electric Company. The amount of power to be transmitted at first is four thousand horse-power. The station will be located in the Santa Ana Canyon, twelve miles from Redlands and about eighty miles from the towns in which the electric power will be utilized. The water will be taken from the river through canal, flume and tunnel along the side of the canyon, whence it will be led into a pipe 2200 feet long, giving what will be equivalent to a vertical fall in the water of 750 feet. The wheels will be of the impact type, directly connected to the generators of which there will be four each of 750 kilowatt (1000 horse-power) capacity. The maximum line potential will be 33,000 volts, to which potential the initial voltage will be raised by twelve 250 kilowatt step-up transformers.

This transmission will be the longest commercial electrical power transmission as yet undertaken, as well as that using the highest voltage. At present the longest is that transmitting the power of the waters of the Ogden Canyon in Utah to Salt Lake City, a distance of 36 miles. The Los Angeles transmission will be over twice that distance, and three times the longest distance yet tried with the power of Niagara, which to date has only been transmitted to Buffalo, a distance of 26 miles.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

THE MECHANICAL ARTS SIMPLIFIED. By D. B. Dixon. Cloth, 5½x8¼ inches, 497 pages. Appropriately illustrated. Laird & Lee, 263 Wabash Ave., Chicago, 1897. Price, $2.50, or as a premium with one year's prepaid subscription to the Journal of Electricity, $1.95.

It is no small task to comprehensively review a work of nearly 500 pages filled to the covers with data and tables of every description, in addition to innumerable rules for the solving of problems in arithmetic, mensuration, gears, centrifugal force—in fact, almost everything. No space is lost in preface or introduction; the index contains 16 pages and as the rest of the book is devoted to solid information of a mechanical and engineering nature, it is at least meaty. In brief, it seems as though the author had ransacked every trade catalogue containing statistics, and every handbook containing data, and every text book containing tables of weights, measures and values, and every school book indicating the solution of problems and had reproduced them all in this one most handy volume.

The Electrical Department of the book consists of 53 pages, 42 of which are devoted to a well-written and intelligible treatise of definitions of electrical words, terms and phrases. After describing at some length the fundamental units of electrical nomenclature such as the volt, ohm, ampere and the watt, and Ohm's law, candle power, and horse power, the various methods of wiring, such as the multiple arc, the series-multiple, the multiple-series, the series, and the Edison three wire systems are taken up and discussed with diagrams in such a simple way as would seem impossible for any one to misunderstand, however unfamiliar he may be with electrical usages. The treatise then passes on to a discussion of the properties of the circuit, touching clearly upon the circular mil, conductors and insulators, the resistance of copper wire, the determination of wires and the method of preparing a wire table, concluding this portion of the subject with several wiring tables for different classes of lighting service. Next is taken up the subject of motors. The wiring for motor circuits and services is discussed and the table is presented showing the amperes per motor at indicated efficiencies for various horse powers up to 150 and various voltages up to 1200. Another table is presented showing the size wire that may be required for any loss that may be adopted. A short section by Charles Wirt on "Simplified Copper Wire Equations" is then given, followed by a number of tables giving the properties of wires. The remaining portion of the electrical section treats of the principles and types of dynamo electric machines with competent points on their care and maintenance, together with descriptions of the various instruments and devices common to central station practices. The Electrical Department concludes in the reproduction of the wiring rules of the National Electric Light Association.

The preceeding paragraph relates only to the electrical department of the book and although electricity is treated more exhaustively than any other subject, it indicates fairly well the thoroughness with which subject matters are handled. Tables of weights and

measures require 11 pages; steam boilers, 14 pages; iron data, 30 pages; mensuration, 6 pages; pipe data, 29 pages; pumps, 6 pages; rope, 4 pages; timber, 3 pages; tubes, 7 pages; valves, 4 pages; wires, 8 pages; and wages, 6 pages. These subjects are taken at random from the table of contents and may serve to give an idea of the scope and thoroughness of the work.

For some time there has been considerable discussion concerning means for indexing technical literature, and it is a question that bids fair to remain a vexed one for some time to come. The necessity for indexing technical data is not, however, likely to be so productive of difficulty in its solution for Mechanical Arts Simplified has set a heroic example in gathering data and bodily republishing it in a form that is at once most handy and reliable.

Those who, in striving for mechanical and engineering data, have been forced to rely on a promiscuous assortment of bothersome trade catalogues for their information, may cast many of them to the winds after having secured Mechanical Arts Simplified for it truly goes a long ways toward solving all mechanical difficulties.

THE THEORY OF ELECTRICITY AND MAGNETISM, being lectures on Mathematical Physics, by Arthur Gordon Webster, A. B., Ph. D., Assistant Professor of Physics, Director of the Physical Laboratory, Clark University, Worcester, Mass. Cloth spring-back, 5½x8¾. Illustrated by 100 geometrical or diagrammatic figures. The Macmillan Company, 66 Fifth Avenue, New York, 1897. Price, $3.50.

It is pointed out in the preface that while some justification is perhaps necessary for the appearance of another treatise on the subject of Electricity and Magnetism, in view of the numerous ones already existing in English, the present work is the result of a demand encountered in the author's experience in teaching, and is based upon various courses of lectures he has delivered in Clark University during the last six years.

The classical treatise of Maxwell, the author observes, is ill adapted to the purpose of a text-book and to ask a student to attempt to assimilate the contents of two volumes of Maxwell in a year, or even in two years, is to expose him to the severest pangs of mental indigestion, and make severe demands upon his mathematical attainments. The excellent treatises of Mascart and Joubert and of Watson and Burbury follow Maxwell with considerable closeness. Professor Gray's admirable treatise, though containing much recent matter, suffers under the disadvantage of being in three volumes, while the very convenient little book of Mr. Emtage is somewhat restricted in scope. Finally, Professor, J. J. Thomson's altogether delightful Elements of the Mathematical Theory, which appeared very shortly before the present book, is extremely modern as well as clear but is addressed to a somewhat different class of students from that contemplated in the book now under review.

Again, the theoretical writings of Hertz, Heaviside, Cohn and others have resulted in the systematization of Maxwell's theory and have made possible improvements in the mode of its presentation and nomenclature not contemplated by him. The extremely important and original contributions of Heaviside are unfortunately but little adapted to the use of the student on account of the very voluminous character as a whole as well as of an extreme conciseness of expression in individual parts. The few brilliant chapters on theoretical matters left by Hertz are hardly by way of exposition, but rather of a summing up of the conclusions of the theory.

It has evidently been the author's aim, in the preparation of this volume to present to the student the results of the theory as it stands to-day after the labors of Faraday, Maxwell, Helmholtz, Herz and Heaviside, in such form as to be suitable for assimilation by the student in a peroid of time not exceeding a year. To this end he has considered only the usual mathematical methods of treating the various subjects and included enough examples to illustrate their working and no more.

Without doubt the book will succeed in clearing up many of the difficulties generally encountered by the student, and will induce him to read the classical writings of Maxwell, Helmholtz, Hertz and Heaviside, the digestion of which will ever be desirable.

Transmission

CHEAP POWER OFFSETS CHEAP LABOR.

Until a very recent time the idea prevailed that California could never become a great manufacturing State for lack of cheap fuel. Accordingly we began to import articles of every-day use from the East, confining our manufacturing enterprise, in a large degree, to wool, flour and lumber, and thinking to go no further. But the successful use in railroading of electrical power generated by impounded streams has made it clear that California, if it will, can have the cheapest form of motive power to be found in the United States outside the districts that enjoy natural gas. To dam up a canyon in the mountains, to hold the winter precipitation for summer use and to apply the force of gravity to the wheels and spindles of manufacture is a very simple way of solving the problem originally made by dear coal. We can work up our own raw materials cheaply with such a system, supply our own wants and those of the great Southwest and have a means of competing with Europe for the custom of the west coast of Spanish America. With cheap power we can counterbalance cheap labor, and with the shorter haul to our credit, undersell European exporters in those markets. So there is commerce as well as home industry to be conserved by our electrical development.

Owing to the topography of California all parts of the State that have aught to manufacture can share in the benefits of the new era. The two mountain ranges which traverse the State from end to end have an exhaustless supply of water, and the distance from them to any of the towns is not so great as to make the transmission of power impracticable. Northern, Central and Southern California are alike favored with streams that can easily be harnessed and made to do the same duty the year round which many of the great manufacturing States and countries are obliged to depend for upon a costly product of the mines.—San Francisco Chronicle.

THE WATER POWERS OF THE SAN JOAQUIN VALLEY.

Beginning at the Northern end of the San Joaquin valley, the first water power of any extent is that de-

veloped by the Blue Lakes Water Company, deriving their water from the Mokelumne River. This Company has for years had an extensive line of ditches used for mining purposes, has recently developed an extensive water power for use in transmission and for mining purposes on the Mother Lode and has in contemplation a still more extensive water power located about 28 miles from Stockton, where in the near future they contemplate delivering power.

Farther south, an extensive water power can be developed on the Stanislaus River, a distance of about 40 miles from Stockton, and some progress has already been made towards the utilization of this power and its use for various manufacturing and other purposes in Stockton.

Next towards the south is the Merced River. Water power to a considerable extent has been planned for development at three points on this river, located at Snelling, Horseshoe Bend, and Jenkins. The first of these is especially intended for supplying power to an electric railway from Merced to the Yosemite Valley.

Still farther south at the head water of the San Joaquin River a water power to the extent of several thousand horse power has been developed by the San Joaquin Electric Company. Electric machinery generating about 1500 horse power, together with transmission line 35 miles distant to Fresno, and arc, incandescent and power machinery in Fresno have been installed for the San Joaquin Electric Company by the General Electric Company. This plant has been in successful operation now for a period of a little over a year and has practically demonstrated both the value of this water power and the success of long distance transmission, this being the longest commercial electric transmission plant in the world.

Next to the south is a water power, planned for development on the Keweah River, a distance of 19 miles from Visalia. About 600 horse power can be developed and plans are already perfected for the utilization of this power for the transmission of electricity to Visalia, Hanford and other near by towns.

Farther south and last on the list is the Kern River, on which an extensive water power has already been developed by the Power Development Company. The General Electric Company has installed a plant for this company with transmission line a distance of 16 miles to Bakersfield, and including motors for pumping and transformers for lighting in Bakersfield. Contracts have also recently been made for an extension of this system to a distance of about 20 miles beyond Bakersfield, making the entire transmission nearly 36 miles. Much of this last mentioned power is used for purposes of irrigation.—Dr. Thomas Addison in the Commercial Bulletin, San Francisco.

A GREAT TURBINE PLANT.

The power company at Niagara Falls has now in successful operation its new power plant, consisting of four of the Leffel Celebrated Niagara Type of Turbines, each of about 2,200 horse power capacity, or giving in all some 9,000 horse power. These Turbines drive eight generators of something over 1,000 horse power each; two generators being connected directly to the shaft of each wheel, one being placed on each side.

This comprises the most complete and perfect electric water power plant in the world.The same company have four other of the Leffel Niagara Turbines, using in all eight of that style of wheel.

Illumination

AN ELECTRICAL RIVAL OF THE ARC LIGHT.

In a contribution to Wiedemann's Annalen, No. 12, Herr O. Schutt, of Jena, describes a new electric discharge phenomenon, which he terms electro capillary light. When the discharge of an induction coil is sent through a narrow capillary tube of about 0.05 mm. in diameter, provided with aluminum or copper elctrodes and filled with air under ordinary pressures, an intense luminosity of the tread of air is obtained—a luminosity which is intrinsically far superior to that of the arc, and would form an exceedingly powerful source of light if it could be made continuous. The narrow capillaries deteriorated rapidly, roughening inside, and were blown into a series of spherical enlargements. Wider tubes gave less light, but were much more permanent. At the same time the bright lines in the continuous spectrum in the original light became more prominent. At pressures above one atmosphere the phenomena were nearly the same, but the sparks passed with greater difficulty. At low pressure the light became less intense, the continuous spectrum faded, and the bright lines shone out more distinctly. The kind of glass is immaterial. It is stated that the tubes may be made 20 centimeters long and make splendid line sources.

ENERGY FROM VOLCANIC HEAT.

The energy stored in the coal beds has rightly been referred back to the sun, and it is, no doubt, to the same source that we should ultimately attribute the heat developed at great depths below the surfce of the earth. While it is believed that no practical attempts to utilize this subterranean heat have yet been carried into effect, there appears to be no good reason why the attempt should not be made, especially in volcanic regions, where quite high temperatures should be revealed at moderate depths. In a Colorado mining town an interesting combination was recently observed which a little ingenuity might have converted into a considerable source of power. Within twenty feet of each other were two springs, one of a temperature of nearly 200 degrees F., and the other not over 60, the flow of each being very uniform and the temperature quite constant. The theoretical efficiency might readily be determined from the well-known law of thermodynamics, and the use of one stream to vaporize and the other to condense some volatile liquid, such as ammonia or bisulphide of carbon, might enable a fair percentage of the energy to be utilized which is now running to waste.—Cassier's Magazine.

NO EYRIE THERE.

The unexpected short-circuiting of one of the 10,000-volt transmission lines of the San Joaquin Electric Company, which recently caused a shut-down of one line for about twenty-five minutes, resulted from a curious cause. Two eagles, male and female, had perched on a live wire near the power house, thirty-five miles from Fresno. The birds were electrocuted, but it was not till after a diligent search that their bodies were picked up and the short circuiting of the wire explained.

Electro-Economics

THE USE AND ABUSE OF TRANSFORMERS.

The distribution of electrical energy by transformers, coming into use as it did at a time when electrical plants were being installed rapidly and the whole electrical business was being expoited in a most vigorous if unsystematic manner, was not, in the

TYPE H TRANSFORMER—20,000 WATTS.

early stages of its development, closely criticized by the users; it was sufficient that this method accomplished results which could not be obtained in any other way.

At the present time, when the electrical business has settled down into more conservative lines, it is of the utmost importance to look over the field and to view, without roseate spectacles, the qualities of the apparatus upon which the success of many electrical enterprises depends, and especially to see what has been done in improving such apparatus and rendering it more desirable and economical to the purchaser. The discussion may be conveniently divided into three parts:

Part i.—The Essential Properties of Alternating Current Transformers.

Part ii.—Proper and Improper Methods of Distribution.

Part iii.—Results Obtained by Exchanging Bad Methods for Good.

Part i

THE ESSENTIAL PROPERTIES OF ALTERNATING CURRENT TRANSFORMERS.

The three qualities which are essential to the successful commercial use of alternating current transformers, are—Durability—Efficiency—Regulation.

It is sufficiently obvious that any transformer which cannot be depended upon, and which is liable to be subject to serious depreciation, is not fit for commercial use. It is of the utmost importance that transformers, which have to be put in all sorts of places and exposed to all sorts of weather conditions, should be thoroughly well made and should be so constructed as to be relatively safe against breaking down of the insulation in either coil, the breaking down of insulation between the coils, and surface leakage. Destruction of the insulation of either coil means very serious damage to the transformer. Destruction of insulation between the coils or at the surface of the transformer means serious danger to life and property. Nearly all the accidents involving these most grave matters have occurred through one or the other of the causes mentioned. In respect to the foregoing, that transformer is best which is most thoroughly insulated, and thorough insulation means not only care in selecting materials and applying them, but such general design that no considerable difficulties are encountered in insulating the transformer, from the shape, position and contiguity of its various parts. In this respect transformers of all makes have improved since the early days of the transformer business, and it is but natural to expect the latest type of transformer to be the best. An inspection of the Type H transformer of the General Electric Company, which embodies the latest and best methods of design and construction, will show how completely these most important conditions have been fulfilled.

DURABILITY.—The illustration of the standard Type H transformer displays very forcibly the valuable character of the improvements which have been introduced in it. In the first place it should be noted that the coils are of such shape that they can be easily wound without danger of bruising and damaging the insulation. There are no sharp corners to be turned and no contracted spaces into which wire has to be forced. There is but one surface of separation between the primary and secondary coils and this surface is a smooth curve, to which insulating material can be uniformly and thoroughly applied without danger of defects in the workmanship, or injury in assembling. It is easy with this construction to allow ample insulation space between the primary and secondary coils, as well as to secure complete circulation of the oil which is generally used in these transformers, in and about the coils, core, and connections. As regards exterior connections, which are of great importance in assuring the safety of the transformer, this type is equally strong. The flexible cables which form the leads are brought out through long porcelain sleeves and the secondary wires are well separated from the primary wires, so that the danger of leakage of primary current over the surface to the secondary wiring is obviated. The relative position of the terminals for the two windings is plainly shown in the illustration and speaks for itself.

Few commercial transformers show so great regard for safety in the placing of the leads or such thorough precautions to prevent the chance of accident. Simplicity of construction and the ease with which all safety precautions can be carried out are excellent guarantees of long and useful life, which means to the operating company both safety and economy—safety not only from serious accidents resulting from bad insulation, but safety from interruption of service, which from the standpoint of dividends is almost equally important, for no company which does not furnish reliable light can expect profitable patronage. It is necessary indeed sometimes to take some chances in the overloading of machinery and transformers, in order to secure this continuity of service, and the importance of having a thoroughly well made

and well insulated transformer which does not run hot, and which can be depended upon to stand up under all sorts of strenuous conditions, cannot be over-estimated.

The shape of the magnetic circuit in the Type H transformers (a long rectangle of interlaced straight strips of iron), is such as leads both to a very simple and effective form of winding the coils, and to an economy in the use of magnetic material which permits a more liberal cross section of copper than is usually found in transformers, thus keeping down the heat generated in the transformers and both permitting the carrying of steady and heavy loads, and preventing the deterioration of insulation under the effect of long continued high temperatures. In respect to these most important properties with regard to durability and certainty of operation, Type H transformers challenge comparison.

The illustrations of the larger sizes of Type H transformers show also the existence of the same valuable characteristics. To certify to the care and thoroughness with which these transformers are insulated, it is only necessary to say that the insulation between primary and secondary is required to stand successfully a test at 10,000 volts alternating for all sizes of transformers and all primary and secondary voltages and on the average a pressure of more than 15,000 volts alternating is required to break down this insulation, corresponding to the maximum voltage of nearly 25,000 volts. To insure certainty of the primary and secondary coils being properly insulated, each transformer is tested, while running hot from its full load, at three times its normal voltage so as to break down and detect any weak points in the insulation. These tests are the severest to which any commercial transformers are put, and the transformer which successfully stands them can be counted upon to do good and efficient service under all ordinary and extraordinary conditions.

Make the insulation between primary and secondary ever so good, there is always a possibility of its giving way under unusual circumstances. Serious overload may char the insulation or it may receive mechanical injury, and even in the best condition it may be pierced by lightning.

While the Type H transformer with its substantial insulation (consisting quite largely of mica between cylindrical surfaces), insures a transformer of the greatest possible reliability, yet the question is often asked—"Can a transformer be made which will absolutely prevent any possibility of a high potential current existing on the secondary circuit?"—To this is replied, that by the use of a so-called "Ground Shield," absolute safety to life or property can be assured. The ground shield consists simply of a sheet of copper covering the entire surface which the secondary winding presents to the primary winding. If this copper sheet is connected to the ground by means of a wire it is perfectly evident that it is impossible for any greater difference of potential to exist on the secondary circuit than that for which the secondary is wound, even should primary and secondary be in actual contact with the sheet.

Other things remaining the same, there must be slightly increased danger (in a transformer provided with such shields), of the insulation being damaged by lightning in its effort to reach the earth, yet experience, which includes one installation of 250 to 300 such transformers situated in a district peculiarly subject to lightning disturbances, shows no appreciable increase of such trouble. It might be added that one prominent fire insurance company already requires that all transformers furnishing current within property insured by it shall be provided with this protective device.

The General Electric Company early recognized the value of immersing transformers in oil, and since January 1, 1891, has constructed its transformers with boxes adapted to its use. While some transformer manufacturers recognize the value of this feature, and will upon special order provide boxes suitable for holding oil, the General Electric Company is the only American manufacturer that makes an oil-tight box standard practice.

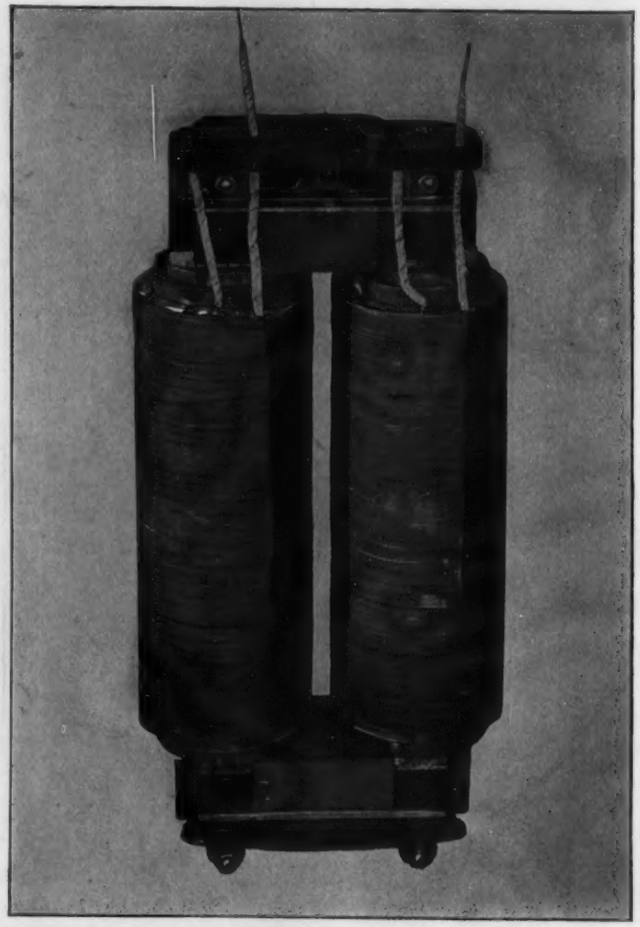
Oil in a transformer serves three distinct purposes:

1st. It increases resisitance against breaking down of the insulation and re-insulates punctures in the insulation.

2nd. It reduces the temperature.

3rd. It preserves the insulation from oxidation.

In regard to the first item,—a potential that will jump through one inch of air, will jump only about one-fifth that distance in most pure oils, and it must therefore be evident that if the small air spaces about and between the mechanical insulation of a transformer are filled with oil rather than air, the resistance to breaking down of the insulation must be markedly increased by the presence of the oil. Not only this, but should the insulation be pierced by a high potential discharge, the oil will flow into the puncture and in a great measure re-establish the insulation. In-



CORE AND WINDING OF TYPE H TRANSFORMER.

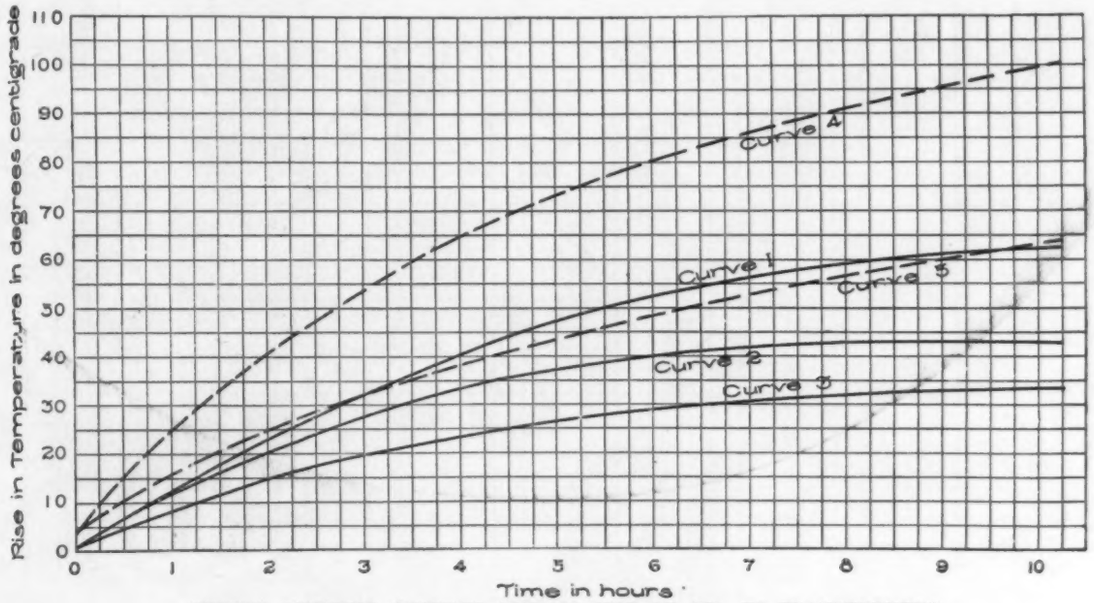
sulation is perhaps fully as often injured by a discharge of a small charge on the line due to the "atmospheric electricity" or to a lightning discharge at a distance, as by a direct lightning stroke. The current from such a discharge is often very small and causes therefore no actual damage other than a minute puncture of the insulation between primary and secondary. Such a puncture when filled with oil does not greatly reduce the value of the insulation.

In regard to the second item,—most heat insulators such as asbestos, saw-dust, etc., prevent the transmission of heat because their structure is such as to enclose throughout their mass, minute particles of air. While the air between a transformer and the case and within the insulation is not confined nearly so closely as in the substances referred to, it cannot circulate freely enough to act as an efficient transmitter of heat. Oil is a much better conductor of heat than stationary air, and moreover, unless confined to very small spaces, convection currents will be set up and carry the heated oil to the cooler surface of the case. The above

curve sheet clearly illustrates these facts. Curve 1 shows the actual temperature by increase of resistance of Type H transformers; Curve 2—temperature of transformers containing oil; Curve 3—temperature of oil; Curve 4—temperature of same size transformers built by one of our most prominent competitors; Curve 5—highest accessible thermometer temperature of the transformer whose actual temperature is shown by Curve 4.

This plainly points out how greatly in excess is the actual temperature as compared with any temperature that can be noted with a thermometer. Purchasers of transformers should therefore not be content with a statement from the manufacturer as to what is the maximum temperature of his transformer, but should insist on knowing the manner in which this temperature is measured.

In regard to the third item,—anyone who has dissected a transformer (having the rise in temperature common to small lighting transformers), after it has been in use without oil for a year or more, knows how very brittle and fragile the insulation becomes even within this short time. At quite moderate temperatures most insulation undergoes a slow process of oxidation that soon causes this undesirable deterioration. If, however, oil is used, the air has no access to the insulation and all oxidation is prevented and the insulation retains its original pliability, thereby indefinitely increasing its life.



CURVES SHOWING RESULTS DUE TO USE OF OIL IN TRANSFORMERS.

While for the following reasons the use of oil is most strongly recommended, it must be recognized that at least in the case of small sizes of transformers there are sometimes well grounded objections to its use. Therefore all of the General Electric transformers are built so as to withstand the 10,000 volt insulation test, and all sizes smaller than 10 kilowatt so that they will run at perfectly safe temperatures when oil is not used.

EFFICIENCY.—As respects efficiency it is pleasant to note that in the past few years there has been great improvement in all transformers. In the early days of transformer practice, the low efficiency of transformers, even when full loaded, was a difficulty often encountered in the proper designing of alternating plants and often brought up against what was otherwise admitted to be a valuable and economical system. The early transformers of all makes left very much to be desired on the score of efficiency. The losses in a transformer are of three sorts,—hysteretic loss, eddy current loss, and copper loss. The last mentioned is comparatively difficult to avert since the specific conductivity of copper cannot be greatly improved by any practical manipulation, so that even in the earliest days of transformer building, good copper was available. Careful design, and the adoption of a better form has effected some improvement, but the greatest change in transformer manufacture has been in the improvement of the iron and the insulation against eddy currents. There is something most mysterious in the properties of iron with respect to magnetic change—not only do these properties vary in the most erratic way, from changes in chemical composition which can barely be detected by analysis, but they also vary in a most extraordinary fashion according to the treatment to which the iron has been subjected. Hence the securing of a proper quality of iron and its proper treatment are matters in which experience counts for everything, and a priori reasoning for very little. The only way to secure low iron loss and low core loss in transformer building is to obtain the best material which can be found and to treat it carefully and intelligently in the operation through which it goes prior to its appearance in the finshed transformer.

It is now a well recognized fact that the loss in a given body of sheet iron subjected to a definite number of magnetic reversals per second and at a definite density of magetization, does not of necessity always remain the same. It is only by the greatest care that iron is brought into the condition in which it gives a minimum loss when subjected to alternating magnetization, and the manner in which this result is obtained and the conditions to which the iron is subjected in actual use have both to be considered to insure keeping in this condition.

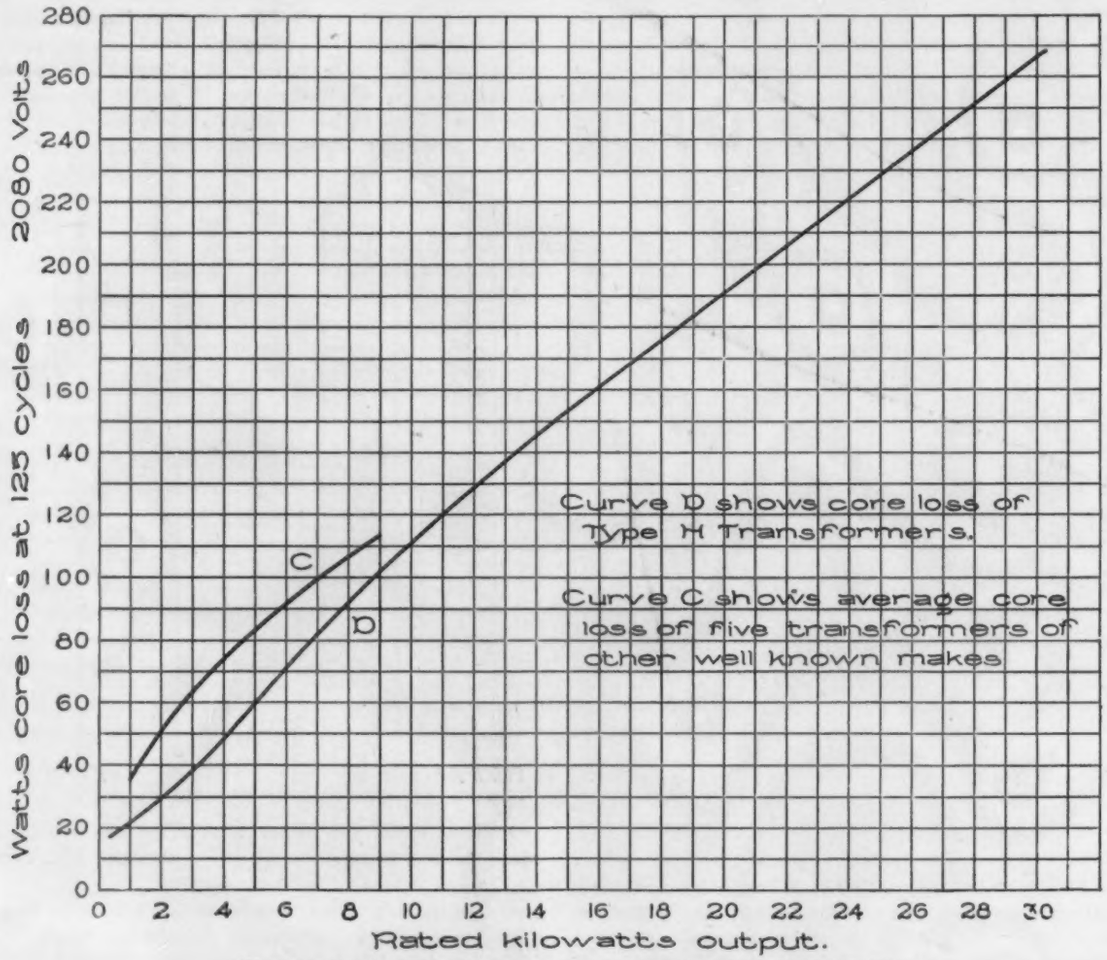
In the manufacture of transformers, failure to properly consider these facts will produce a transformer which may give a fairly low core loss when first produced, but which after being in use for a short time will give a core loss 25 per cent, 50 per cent, or even 100 per cent greater than at the start.

This phenomenon is popularly known as Magnetic Fatigue or Ageing. The General Electric transformers are practically free from this most serious defect; in most cases the core loss due to ageing is absolutely negligible and in extreme cases it is not more than 4 per cent on 5 per cent. On th accompanying curve, actual results obtained on a standard Type H transformer are given, which, it will be observed, come readily within this limit. There is also given as a practical illustration of this defect, a curve of actual results recently obtained on a 2,500 watt transformer of other well known make. At the time of last test the increase in core loss was, it will be seen, 68.9 per cent after a run of 90 days under normal conditions of commercial operation.

The improvement in the matter of core loss, even in skillfully designed transformers of the same make, owing to better facil-

ities for getting good iron, and greater knowledge of treating it, has been profound. The difference in core loss between the early transformers manufactured by the Thomson-Houston Company, and the Type H transformers, which have succeeded and will supersede them, is prodigious. The core loss of the early transformers referred to, from hysteresis and eddy currents, is more than four times as great as is found to-day in the Type H transformers.

A large core loss of course lowers the efficiency of the transformer, and since that core loss is nearly constant for all loads it lowers the efficiency most seriously at light loads. This is but a special case of the general theorem as to any mechanical or electrical apparatus. Constant losses cut down the efficiency more and more as the decreases because they are a greater proportion of the load. Consequently we find that in these old transformers



COMPARATIVE CURVES OF CORE LOSSES IN TRANSFORMERS.

while the efficiencies at all loads are inferior to the efficiencies of the Type H transformers, the efficiencies at low loads compare very much more favorably than those at high loads. For example, the efficiency of a Thomson-Houston, 1,500 watt Type E transformer at full load, was 92 per cent. The Type H transformer of the same size has at full load, an efficiency of 95.9 per cent, but at one-quarter load, where the latter transformer still has an efficiency of 92.5 per cent (greater than that of the Type E transformer at full load), the Type E transformer had an efficiency of but 79 per cent, and was better than most of its contemporaries, and as good as most of the cheaper transformers put on the market to-day.

Efficiency at low loads is one of the most valuable properties which a transformer can possess, because it unfortunately happens that in most of the alternating practice up to the present time, low loads are the rule throughout the operation of the plant, and high loads the rare exception. This is an unfortunate state of things which has naturally resulted from the methods of installation followed in all the early plants, and in some recent ones. It has been almost universally the custom to install a transformer to supply the needs of each consumer. Now certain classes of consumers, in particular, shops, require most of their lights to be burning for only a short time during the evening, while for the greater part of the day no lights are used and only a few lights during most of the hours when lights are needed; consequently for the greater portion of the time the transformer is either operating under-loaded and subject to its steady core loss, or is very lightly loaded, and working, therefore, at a very bad efficiency.

Even more aggravated are the conditions existing in domestic lighting. A residence is usually equipped with lights in every room, and at times all the lights, or nearly all of them, are likely to be in use, so that the transformer capacity must be great enough to take care, in such an emergency, of all the lights installed. Nevertheless for the most part the transformers used for residence lighting are exceedingly lightly loaded, perhaps only half a dozen lamps may be burning out of twenty-five or thirty installed. Consequently the transformer is working at one-quarter load or less from one year's end to the other with occasional rare exceptions. Under these circumstances a high efficiency at light load is absolutely necessary for the preservation of decent station efficiency and proper returns from the investment.

In the early days of incandescent lighting, when lights were habitually installed by contract, one could count on most of the lights installed being used, so that the worst which could happen was the installation of a large number of very small transform-

ers. Now when electric lighting is almost universally metered, the number of lamps installed is relatively much greater than under the old regime, and therefore while nearly the same number of transformers have to be installed, these transformers have to be proportionately somewhat larger than the former, and consequently are relatively more lightly loaded, and run relatively less efficiently, so that with the practice of metering it becomes doubly essential to use transformers which are of high efficiency, not only at full load, but at light load, at which they are likely to be run, and in which the core loss is so small that when the transformers are entirely unloaded the amount of energy wasted in them shall be a minimum.

It was with this particular point in mind that the Type H transformers were designed and are being put upon the market. They are actually of higher efficiency at one-quarter load than are a large proportion of the commercial transformers now in use, at full load. The effect of this enormous improvement in economy of operation of the station can hardly be over-estimated, and we will look into it carefully later. It is sufficient here to note that the core oss in these Type H transformers is from one-third to one-half less than is found on the average in recent transformers of other good makes. This is not unnatural, since low core loss was one of the essential properties with reference to which these Type H transformers were designed.

This superiority of the Type H transformers is shown in no way more strikingly than by the following curves. The curve D shows the total core loss in the different sizes of Type H transformers up to 30 kilowatts, and the curve C, plotted on the same scale, shows the average core losses of five transformers of other well known makes as represented, not by ex-parte tests, but by the claims made by the respective manufacturers.

Personal

Mr. John Martin has gone East on a business trip and will probably be absent thirty days.

Mr. C. S. Knowles, of the "Seven Arch" street electrical supply house in Boston, was in Southern California during the latter part of June.

Mr. Edgar C. Gribble has been appointed to the position caused by the death of Mr. John R. Regan, late Chief Electrician of the Palace Hotel, San Francisco.

Mr. John B. McKilligan has resigned the general managership of the Victoria, B. C., Street Railway & Lighting systems to enter his own business as Mining, Real Estate and Financial Agent at Kalso, B. C.

Mr. E. T. Pardee, of the home business office of the Fort Wayne Electric Corporation, has reached San Francisco and will be located in the Pacific Coast Agency of that concern for an indefinite period.

Mr. C. O. Poole has been promoted to the vacancy caused by the resignation of Mr. E. A. Roe from the Superintendentcy of the Electrical Department of the San Francisco Gas & Electric Company. For several years Mr. Poole has been in charge of the Townsend Street Station and his promotion elicits satisfaction on every side.

Mr. Edward A. Rix has retired from the Rix Compressed Air Machinery Company and will hereafter engage in business independently as the Rix Engineering and Supply Company, handling both electrical and pneumatic machinery, with permanent offices on the second floor of the building on the south east corner of First and Market streets, San Francisco.

Prof. R. B. Owens, of the Department of Electrical and Steam Engineering of the University of Nebraska, has been placed in charge of the Department of Electricity of the Trans-Mississippi Exposition and his appointment insures the overwhelming success of the electrical section for his personality is the embodyment of the chief attributes of success,—unquestioned ability, unlimited energy, practical experience and personal popularity.

Educational

VAN DER NAILLEN GRADUATES.

The Thirty-third annual list of graduates (1897) of the Van der Naillen School of Engineering of San Francisco, contains the following names in the Electrical and Mining Departments:

Electrical Department—R. A. Huntington, city; E. Nelson, city; S. S. Thompson, Billings, Mont.; B. Coffin, H. J. Wilson, city; R. S. Andrews, Honolulu; F. F. Dreschler, Port Costa; L. E. McKay, Oakland; G. H. Stockbridge, Los Angeles; George Vivion, Yuba City; N. McAuslan, Sutter, Cal.; C. Langerman, Yukon, Alaska; Thomas Oriel, Mexico; B. Miller, Grass Valley; A. R. Talamentas, Compton, Cal.; E. M. Reynolds, Lathrop, Cal.; F. Kinsman, city; C. Krasilnikoff, Siberia.

X Ray Department—O. W. Lutz, Napa; Elizabeth Fleishman, city; W. H. Hennessey, city.

Mining Engineers—G. L. Gruss, Genesee, Cal.; John Andrews, Middleton, Cal.; C. Maack, Petaluma; W. B. Duesler, Globe, Ariz.; E. Matterson, Shasta, Cal.; R. Trengove, Neuman, Cal.; R. Von Reischach, Antofogasta, Chile.

Obituary

JOHN R. REGAN.

It is with regret that announcement is made of the death of Mr. John R. Regan, of pneumonia, at San Francisco on June 18th last.

Mr. Regan was a Native Son of the Golden West, having been born in San Francisco in 1862. He entered the electrical business early in life, being one of the earliest of the employees of the Sutter street electrical supply house that formed one of the concerns which afterward developd into the California Electric Works. While yet quite young, Mr. Regan went east and became associated with the original Sawyer-Man Electric Company, with which concern he remained until after its alliance with the Thomson-Houston Electric Company. His exceptional ability in the handling of workmen was the cause of his being placed in charge of the installation of the Patterson, N. J., plant and after it was in satisfactory operation, he returned to New York where he at once entered the service of the Harlem Electric Lighting Company, then controlled by the New York Electrical Construction Company. The supervision of construction seemed to be his penchant, however, for his next change was to Utica, N. Y., where he remained in charge during the construction of the Utica Electric Light plant.

It was about this time that the painful affliction of inflammatory rheumatism laid its racking hold upon him and for two years his sufferings were so great as to render him an invalid. Realizing that a marked change in climate would probably do him more good than anything else, he returned to California in 1890 and at once entered the service of the Electrical Improvement Company of San Francisco in the capacity of superintendent of incandescent construction. His return to health upon arrival in California was very rapid and the thoroughness of his work gave additional endorsement to the reputation he had already borne for ability in this direction. With the absorption of the business of the Electrical Improvement Company by the Edison Light & Power Company, Mr. Regan entered the service of the Palace Hotel as Chief Electrician, where he remained until his death and it is a fitting tribute that of the many who mourn his loss, the kindest words in his memory are those of former employers who early recognized him to be a man that was generous always, yet who never permitted personal friendships, relations or interests to interfere to the slightest degree with the execution of business.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

A DIVIDEND AND A BIG CONTRACT.

The Westinghouse Electric & Manufacturing Company, on Tuesday June 22nd, 1897, declared a regular quarterly dividend on its preferred stock of 1¾ per cent.

On the day following, the annual meeting of the stock-holders was held at the factory of the Company in East Pittsburg, Pa., the annual report of the Company was read, showing its condition to be prosperous. The Board of Directors of last year were re-elected, being composed of—August Belmont, Lemuel Bannister, Geo. Hebard, Henry B. Hyde, Marcellus Hartley, A. M. Byers, N. W. Bumstead, Chas. Francis Adams, Brayton Ives, and Geo. Westinghouse, Jr.

After the meeting, it was announced that the St. Lawrence Construction Company had, on June 18th, awarded to the Westinghouse Company, a contract for fifteen 5000 h. p. generators, which are to be erected at their plant at Massena, northern New York. This is the largest single order ever given for electrical apparatus and the amount directly involved is about three quarters of a million dollars.

This contract, together with that recently given by the Catarract Construction Company of New York, for five 5000 h. p. generators, for installation at Niagara Falls, N. Y., makes a total of twenty 5000 h. p. generators, having a total capacity of 100,000 h. p. which have been ordered from the Westinghouse Electric & Manufacturing Company this year.

AN EVIDENCE OF PROSPERITY.

It is a positive enjoyment to call at the new offices of Mr. John Martin, Pacific Coast agent for the Stanley Electric Manufacturing Company and of Fred M. Locke, where everything is home-like and inviting. These attributes are due to the agreeable personnel of the office and to the simple comfort of its furnishings, and no one need not feel at home there.

The new offices are located at 300 California street, on the north west corner in the building recently vacated by the Grangers' Bank. The offices are located on the ground floor and the basement of the entire building is used as a packing room and for the storage of the large stock of Stanley motors, transformers, instruments, etc., and of the Locke insulators and line materials, that is carried. The growth of business which necessitated the removal of Mr. Martin's agencies to such well-appointed offices, bears testimony to the popularity and merit of the apparatus there represented.

Mr. John R. Cole, of 115 New Montgomery street, San Francisco, announces that he has secured the agency of the Cutter Electric & Manufacturing Company, of Philadelphia, manufacturers of the well known "C. S." Flush switches, and the "I. T. E." (Inverse Time Element) Circuit Breakers for both alternating and direct currents.

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